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1931

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MACHINES AND CLUTCHES

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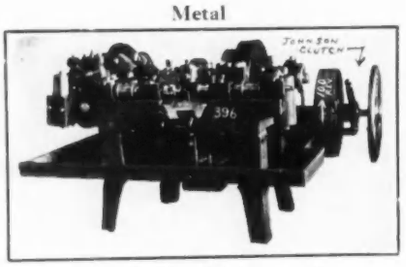

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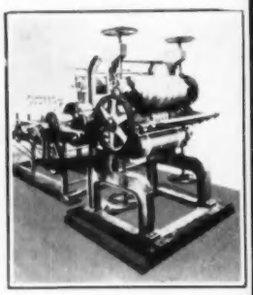

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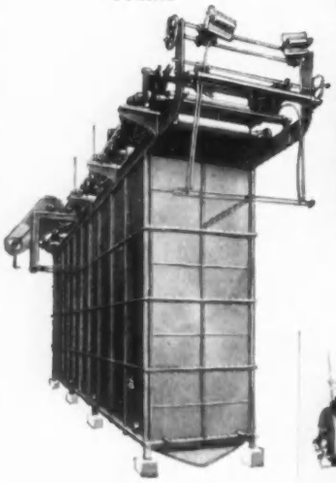

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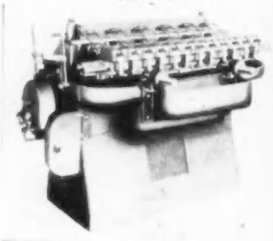

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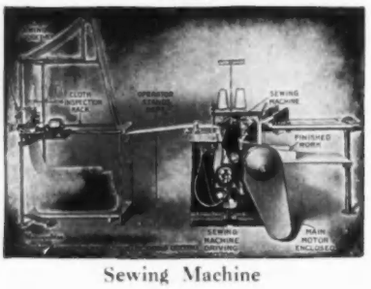

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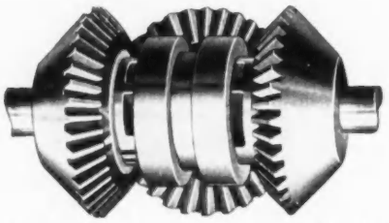
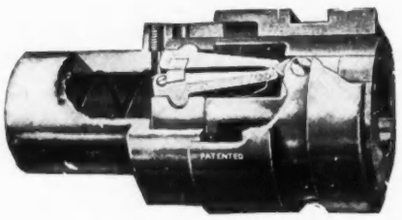
Double Clutch—Exterior

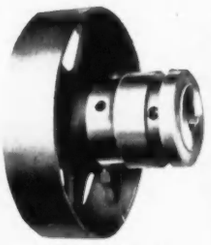


Double Clutch Between Bevel Gearing



Single Clutch—Sectioned

Single Clutch—Exterior



Single Clutch with Pulley

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—*said* CHARLES S. DAVIS
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Sometimes salability means appearance, sometimes it means performance, again it stands for strength. In any event it is the thing that makes it possible for the purchaser to buy to advantage, for the manufacturing department to produce and for the salesman to find and convince the buyer. Where can the engineer find it in his own individual case?

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The next step to take is to find ways and facilities with which to make correction and here is where Product Engineering fits to best advantage. It gives you salability suggestions whether strength, or performance or appearance is involved, whether you are engineering toys or locomotives.

Find your points of salability, get approval to put them in your product and you will help your salesmen make more commissions.

PRODUCT ENGINEERING

A McGraw-Hill Publication AUGUST Volume Two, Number Eight

PRODUCT ENGINEERING

1931

Hydraulic Operation of Machinery

Basic principles and advantages of hydraulic transmission of power have long been known, but it was not until the design of compact and flexible pumps and controls had been developed to commercial perfection that this system came into general use, and today rapid strides are being made in the adoption of hydraulic operation for machinery of all kinds. In this series of articles the fundamentals of hydraulic operation, the features in the design of pumps and controls and their applications, will be set forth. The first articles will deal with the construction and operation of some of the outstanding types of hydraulic pumps. Later articles will give practical applications

APPLICATIONS of hydraulic drives and controls to a great variety of machines have increased rapidly in recent years. Engineers are coming more and more to realize the convenience and flexibility of this means of speed and torque conversion. Although the principles are not new, the modern units and systems employed, and the advantages and limitations of hydraulic conversion devices merit wider [illegible] by product engineers.

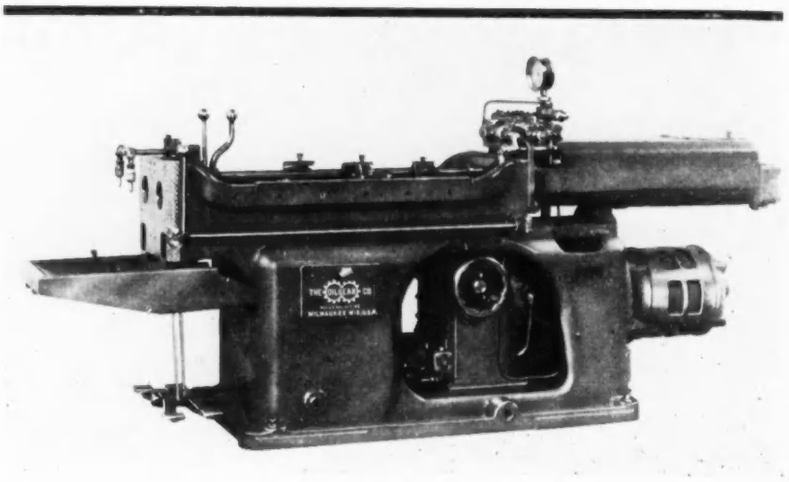
All such systems involve a pump, suitable piping or its equivalent, and a means for applying the fluid and pressure delivered by the pump. Usually one or more control valves and sometimes an accumulator and various other secondary elements are added.

In an ideal system the pump delivers, except for slippage or leakage, the exact quantity of liquid used by the pressure-applying means, whether it be a hydraulic motor or merely a pressure cylinder and plunger. Consequently, if this delivery end of the system requires a constant volume of the liquid used, a pump furnishing a constant volume of liquid answers all requirements. If, however, the volume of liquid used at the delivery end fluctuates between wide limits, as it often does, several alternatives present themselves:

1. A constant-speed variable-delivery pump can be used.
2. The speed of almost any type of pump can be varied in synchronism with the demand, perhaps starting and stopping at frequent intervals.
3. A constant-speed constant-delivery pump can be employed and the fluctuations in demand can be met by employing an accumulator, by by-passing a part of the liquid pumped, or by using various other expedients.

All of these expedients present both advantages and disadvantages, as will appear later. Some of the factors to be considered include: simplicity, dependability, and initial

cost of the pump and the accessories required, pressure head to be pumped against and volume of liquid to be pumped in a given time, mechanical efficiency and volumetric efficiency as affecting the power consumed, and heat transferred to the oil circulated, relative ease and accuracy of control and general character of service involved. It is evident, however, that there is need for two distinct classes of pumps, namely, constant-delivery and the variable-delivery types, especially when a constant-speed power source, such as the ordinary electric motor, is used for the driving of the pump.

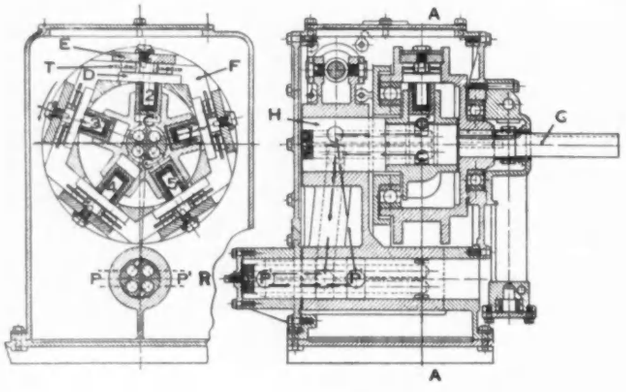


HORIZONTAL broaching machine with Oilgear pump arranged for automatic and semi-automatic operation

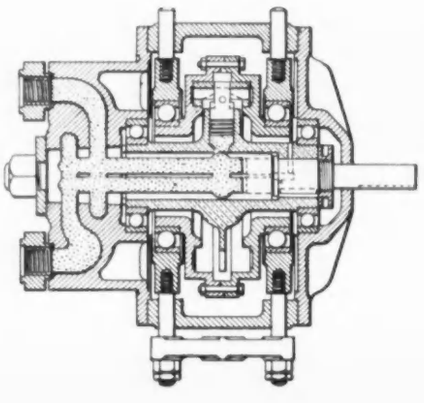
The fields of each class are distinct in most instances, but tend to overlap in others. Often the deciding factors are flexibility, or range of control, and accuracy of control of the driven element, usually a plunger. Flexibility obtained through excessive throttling of a constant-volume pump results in heating of the oil with consequent reduction in viscosity and loss in efficiency and control. It is the limiting case of overlapping in the field of application with the variable-delivery type.

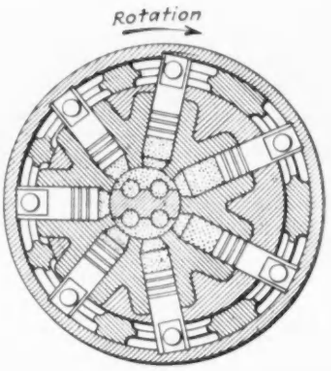
Pumps capable of variable delivery by reason of variation in stroke are of several types. Those having radially-disposed cylinders are exemplified by the Oilgear and Hele-Shaw designs. Others have cylinders parallel to the axis of rotation, as in the Waterbury design. In all these designs there are a multiplicity of cylinders in order to minimize pressure pulsations, and in some the cylinders revolve. Stroke variation in the radial cylinder designs is accomplished by varying the eccentricity of one member in reference to another. In the type with cylinders parallel to the axis of rotation the stroke is varied by changing the angle of the wabble plate to which the pistons are linked by ball-end rods.

Another type of variable-delivery pump having radially disposed cylinders, but of marked difference in constructional details from the Oilgear and Hele-Shaw pumps, has been developed by the John S. Barnes Corporation. It is so designed that the pump automatically ceases to discharge any liquid as soon as the fluid motor (usually in the form of a piston and cylinder) comes up against a positive stop. As in other types of variable-delivery pumps, means are provided for varying the eccentricity of one member with respect to the other, to vary the delivery.



TYPICAL oilgear pump, showing section through the radial cylinders and central arrangement of ports





HELE-SHAW pump in axial and transverse section, showing arrangement of the radial cylinders, floating ring in its maximum off-center position, and its track with slippers on which the pistons are pivoted, and ports for oil flow

According to the manufacturer, control is fine enough to produce a discharge of 1 cu.in. of fluid a minute at a uniform rate, and the flow is entirely free of pulsations, the reciprocating motion of the pistons being purely harmonic.

There are five radially disposed cylinders. Pivoted fingers are interposed between the ends of the simple cylindrical pistons and the outer race of the ball bearing eccentric giving simple harmonic motion to the pistons. The fluid motor cylinder is connected on each end to the pump making a closed hydraulic system with fluid on both sides of the pump piston. Fluid pumped in on one side of the piston of the motor displaces an equal quantity on the other, giving positive control and eliminating the possibility of jump, should the work reaction be removed suddenly. By means of a rotary valve, on the up stroke the pump piston is connected to the driving side of the fluid motor and on the reverse stroke to the other. Thus, fluid expelled from the work cylinder returns to the pump and forces the pistons back against the retreating eccentric. Half a revolution later the fluid reverses in any one pump cylinder and related passages. Should the work piston come against a positive stop, no liquid can flow in the system, and the pump pistons remain in a neutral position producing a controllable pressure in the system.

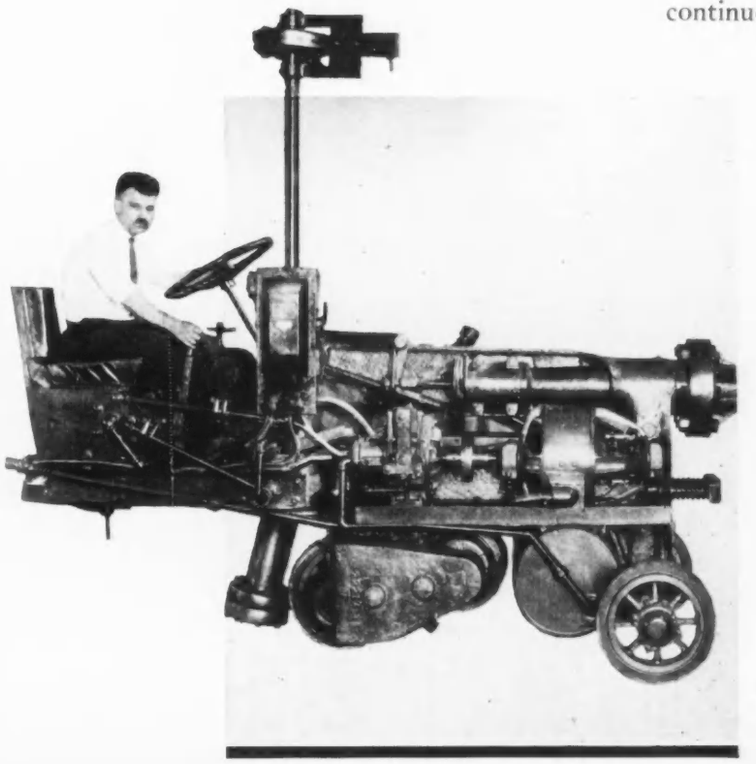
Other variable-delivery pumps include one made by the Aldrich Pump Company, in which a pair of crankshafts, the phase of which can be varied and a link pivoted on the plunger is used to vary the stroke; a rotary vane pump made by the Landis Tool Company in which means are provided to change the relative eccentricity of the rotating element.

Pumps of these descriptions have several advantages, but their primary reason for being is their ability to vary their delivery, usually from zero to maximum, in infinitesimal steps and as slowly or rapidly as desired without changes in efficiency of sufficient magnitude as to involve excessive heating of oil when this is being recirculated in a closed system. The plunger type of pump, in particular, is capable of developing moderately high pressures without excessive slip, and the other types are capable of developing ample pressure for many types of machine. Compact grouping of cylinders in some pumps of this class makes for short passages and simplifies valve design and arrangement, and permit unobstructed flow of the fluid.

Variable-stroke pumps are self-contained units that often make it possible to avoid the use of accumulators and certain other supplementary units. As a rule they also minimize the power losses which occur when wire-drawing through control valves takes place, as it does when throttling of the pump discharge is resorted to as a means of varying the volume of liquid pumped. Pumps of the variable displacement class lend themselves to combination with hydraulic motors of almost identical construction, thereby forming speed-varying devices which afford a wide and continuous variation in speed and torque, usually without excessive heating of the liquid pumped, which is a consideration of importance especially when the volume of liquid in the system is comparatively small.

Such variable-speed transmissions are readily built into or combined with a variety of machines, and provide a smooth and convenient means of control. They are employed in some cases not only for the main drive, but for supplementary operations, such as feeding or positioning various units, or for actuating different parts hydraulically at almost any speed.

Oilgear variable-delivery pumps are



BROSIUS auto floor charging machine actuated by the motor-driven Hele-Shaw pump seen in the center of the vehicle

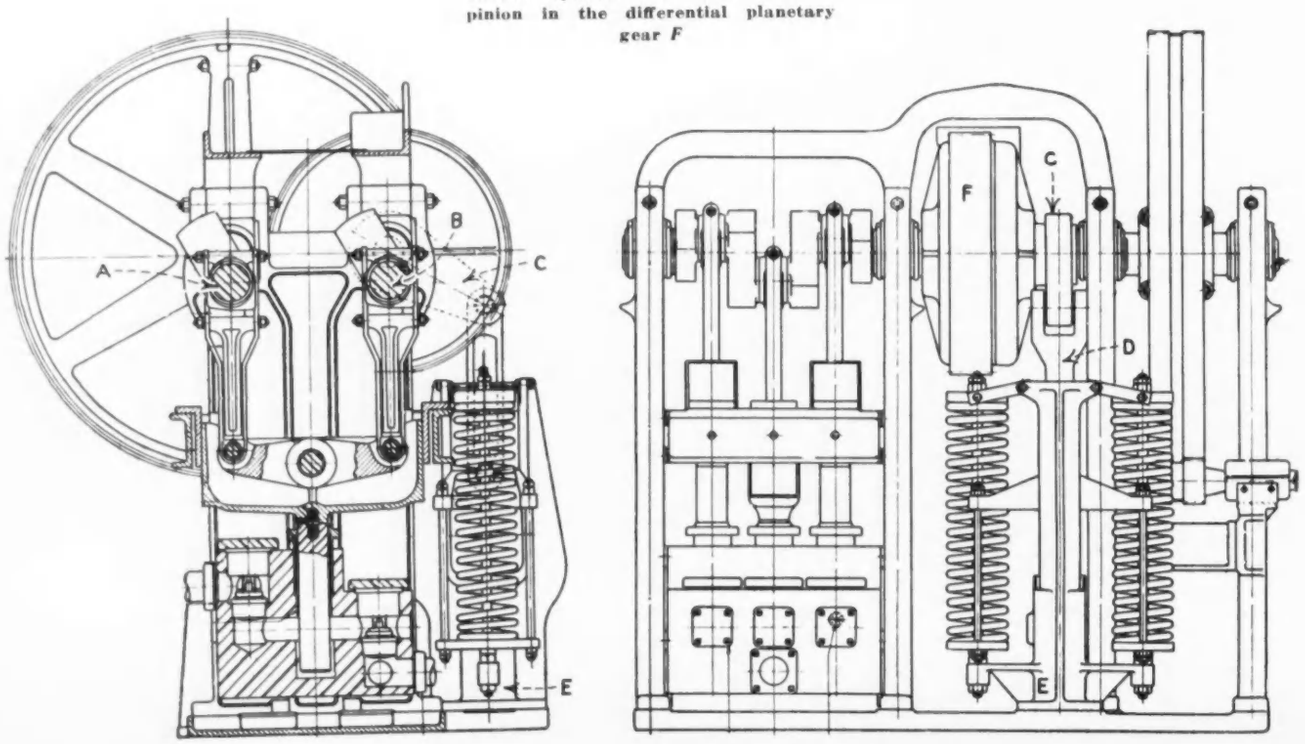
of various types and sizes and generally include within a given unit a constant-delivery gear pump for supplying back pressure and operating controls and auxiliaries. In principle, however, the variable-delivery part of the pump comprises a rotating cylinder block having five or more radial cylinders, and a rotating driving member which carries the pistons. Both the driving member and the cylinder block rotate within a case which acts as an oil reservoir. The axis of the driver, which rotates in bearings in the case is fixed, but that of the cylinder block is on a swinging arm or pendulum which can be rocked, thereby moving the cylinder block axis in reference to the fixed axis of the driver. When the two rotating parts are co-axial the pistons do not move in reference to the cylinders, and no oil is pumped, but when the axes are separated, relative motion between cylinders and pistons occur and pumping takes place, the stroke and volume pumped being proportional to the distance between the axes. Since the movable axis can be placed at either side of center, oil flow can be reversed at will.

Cylinder heads are in contact with the stub shaft about which they rotate, and ports in these heads register successively with corresponding ports in the shaft, performing the function of valves to control the flow of the oil. Crossheads to which pistons are attached do not bear directly upon the driver, but each head has a cage of rollers interposed between it and a corresponding flat surface of the driver. Since bearing parts are hardened and run in oil, wear is minimized. Pumps of this make are designed for 1,000, 1,500 and 2,500 lb. per sq.in. operating pressure, but are capable of carrying overloads for short periods. They are used extensively in machine tool and many other applications, especially for actuating plungers, and are often combined with hydraulic motors constructed in much the same way as the pumps, to form hydraulic transmissions on installations with overall efficiency rating as high as 88 per cent at full speed and torque.

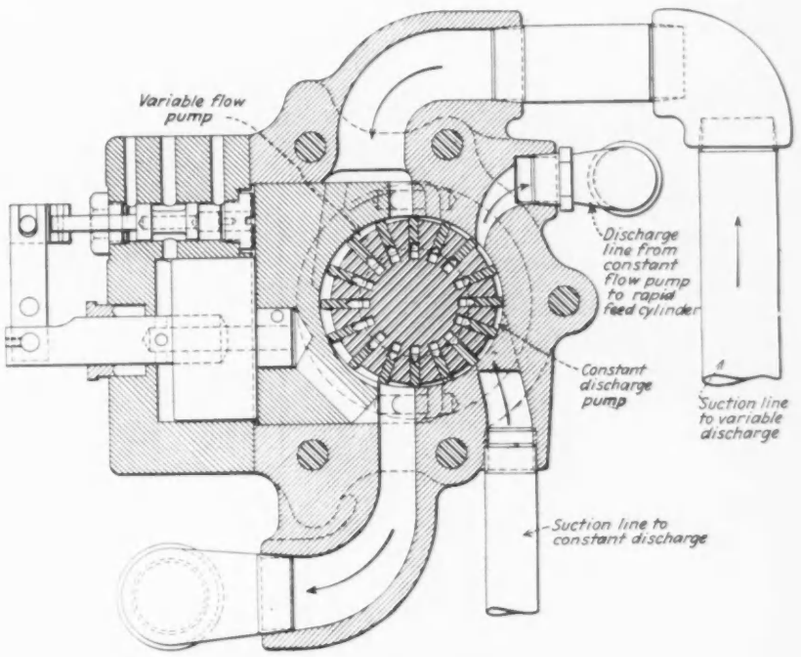
Hele-Shaw pumps also have radial cylinders, but in this case they form the driver member which rotates about a fixed axis. The pistons in this pump are attached to pins that bear in slippers or rollers which, in turn, are carried in circular grooves in a floating ring. The latter rotates in bearings supported in suitable guide blocks arranged to slide crosswise of the case attached to the casing. When shifted along the ways the axis of the ring can either be made to coincide with that of the cylinders, in which case no pumping action takes place, or can be moved to one side or the other of the fixed cylinder axis. The degree of eccentricity or distance between fixed and movable axes, determines the length of stroke and consequently the volume pumped. By shifting the movable axis from one side to the other the direction of the flow of the oil is reversed.

Pumps of this type, being similar in general principle to

ALDRICH variable-displacement pump. Its stroke is changed by varying the relative angular position of the two crankshafts *A* and *B* by shifting the lever *C* connected by link *D* to hydraulic cylinder *E*. This rocks a pinion in the differential planetary gear *F*



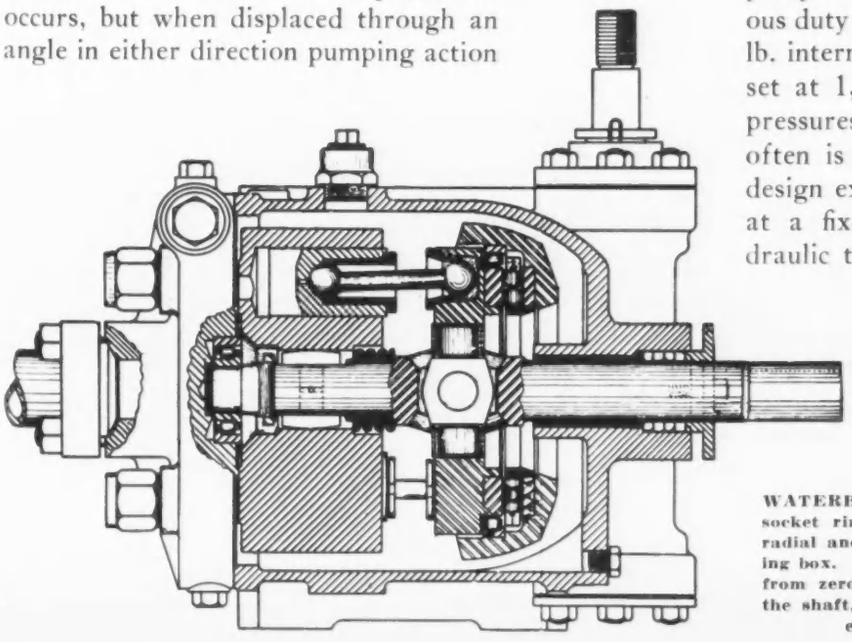
the Oilgear, are employed for much the same class of applications. They are designed for pressures up to 3,000 lb. per sq.in. Oil that leaks past the plungers enters the grooves in the floating ring and keeps the parts that run in these grooves lubricated. Other parts run in oil, and so require no other lubrication. Oil enters and leaves the pump through passages and ports in the fixed shaft about which the cylinders turn. These ports register with corresponding cylinder ports, thus timing the flow of the oil into and out of the cylinders.


Variable flow pump
Discharge line from constant flow pump to rapid feed cylinder
Constant discharge pump
Suction line to variable discharge
Suction line to constant discharge

SECTION through Landis double-type pump showing variable-delivery at top and fixed flow at bottom

In the Waterbury pump the cylinders are bored with their axes parallel to the axis of rotation, and the pistons are driven by connecting rods having ball-shaped ends. One end of each rod fits a socket in the corresponding piston and the other end fits a similar socket in a socket-ring or wabble plate. The latter is mounted on trunnions at right angles to the main shaft and can be rocked about these trunnions by changing the angle of the tilting box in which the plate is supported against radial and thrust roller bearings. This tilting box does not rotate, but is held in trunnions and is provided with slidable means for rocking it about these trunnions. When so rocked the wabble plate is set at this same angle and the stroke of the pistons is varied correspondingly, as is also the displacement of the pump. When the socket ring is at exactly right angles to the axis of rotation no displacement occurs, but when displaced through an angle in either direction pumping action follows, the direction of the flow depending upon which side of the neutral position the ring is rocked.

A fixed valve plate is fitted against the end face of the cylinder block, and is provided with inlet and outlet ports with which the cylinder ports register alternately as oil is drawn into and discharged from the cylinders. Action is very similar to that of the radial cylinder pumps just described and the Waterbury pump is applied for similar purposes, making a compact and self-contained unit capable of variations in delivery from zero up to the maximum capacity of the pump. The latter is designed for continuous duty at 400 lb. per sq.in. pressure, or 500 lb. intermittent service, but relief valves are set at 1,000 lb. so that high instantaneous pressures can be developed. This pump often is combined with a motor of similar design except that its wabble plate is placed at a fixed angle, the unit forming a hydraulic transmission, the efficiency of which



WATERBURY pump in vertical section. Its socket ring or wabble plate is mounted in radial and thrust roller bearings in the tilting box. The stroke of the pump is increased from zero, with the ring at right angles to the shaft, as shown, as the ring is tilted to either side of this position

is said to exceed 80 per cent when operating above 50 per cent of normal torque and speed. A high-grade lubricating oil having a viscosity approximating 320 sec. Saybolt at 100 deg. F. is recommended as the fluid to be pumped and this fluid serves as the lubricant.

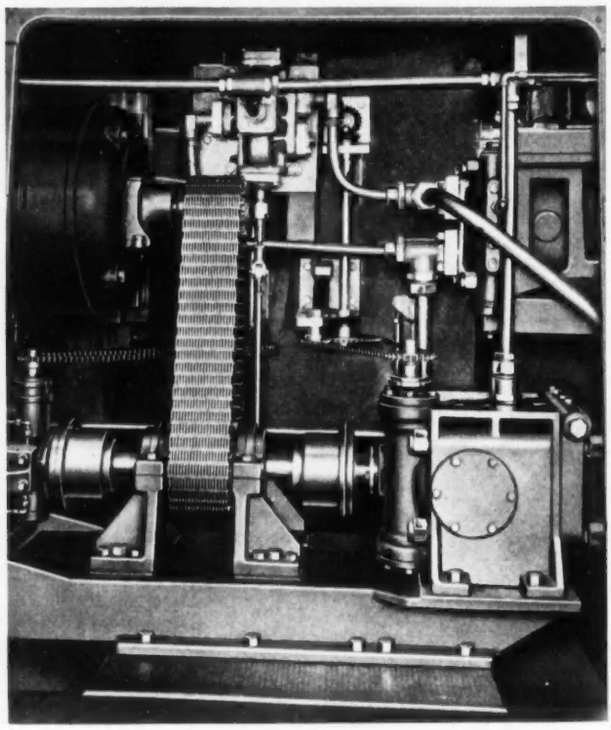
An example of a Waterbury pump combined with hydraulic motors for power transmission and control is given in an accompanying illustration. Two pumps are mounted in tandem in the base of a horizontal cylinder grinder and driven by chain from a 25 hp. motor. The pump at the left provides power for a hydraulic motor that drives through a two-speed transmission to a bull gear on the spindle. High-starting torque on the hydraulic motor is eliminated by the two-speed transmission, especially when starting spindle revolution with the grinding head expanded against the cylinder wall. The pump at the right furnishes power for feeding the spindle. From the pump the fluid passes through a 4-way valve to a hydraulic motor. Control of the 4-way valve is effected by a linkage connected to the crosshead of the machine.

A much less compact form of variable delivery pump than those thus far described, but one capable of developing pressures up to 4,500 lb. per sq.in. and intended for pumping water, is a triplex (three-plunger) pump made by the Aldrich Pump Company. It resembles a conventional triplex reciprocating pump, except that two crankshafts connected by differential planetary gearing and two sets of connecting rods that operate the plungers through interconnected rocker arms, are employed. When the respective cranks are in the same angular position, the rocker arms remain in a horizontal position and impart a full stroke to the plungers. By changing the angular position of the cranks, however, the length of stroke is changed in proportion to the angular or phase difference, until, when the cranks are 180 deg. apart, the stroke becomes zero. The cranks are positioned through differential gearing.

Change in phase relation of the crankshaft of this pump is effected by turning a lever keyed to the stub shaft that carries the central pinion of the planetary system. This pinion meshes with the two planet pinions at each side of it, mounted one on each crankshaft and meshing in turn with the internal gear which is driven at constant speed from a layshaft geared to an electric motor. Movement of the lever controlling the phase relation of the two cranks is effected by a link pivoted to the upper end of a plunger in a hydraulic cylinder. The latter is attached to the pump base and is connected to the pump discharge by a small pipe. This movement of the plunger compresses two pairs of heavy springs which return the control plunger when the pressure under it is released. Since the pump itself in this unit is identical with reciprocating pumps to be dealt with in a succeeding article, no description need be given here.

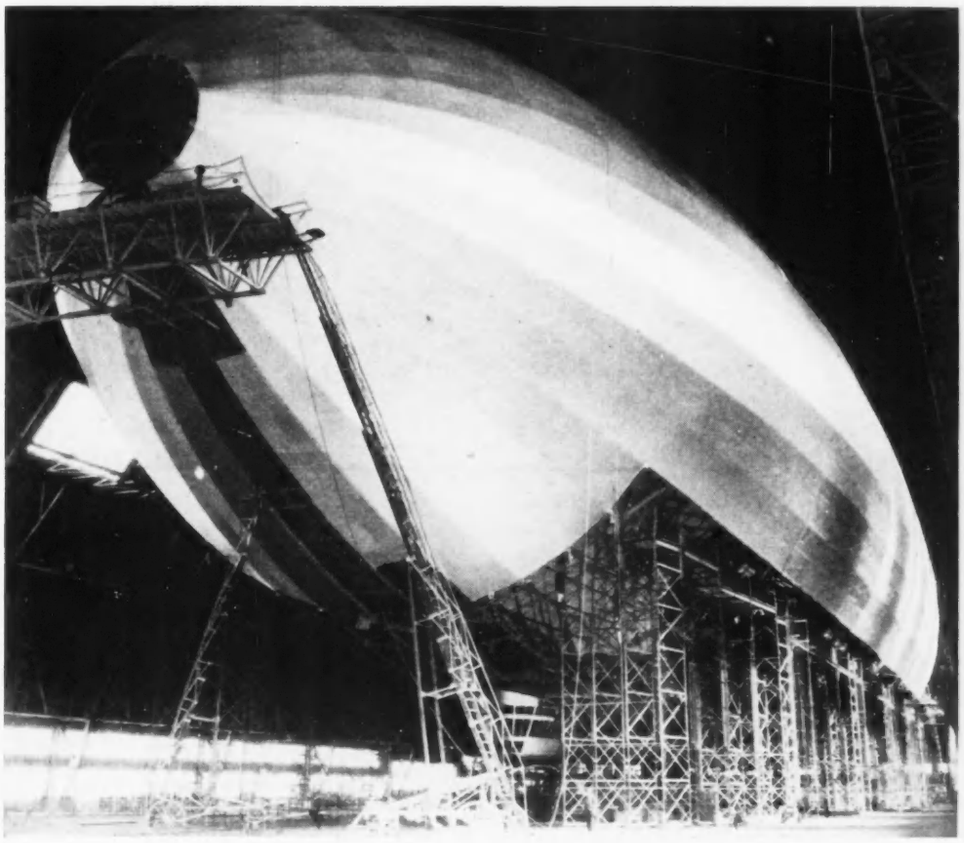
Centrifugal pumps sometimes are filled with discharge valves to vary their delivery, but since the pump itself is not altered in this case, particulars regarding it are given in a later article dealing with this pump as a constant-volume type.

In the Landis Tool Company variable-delivery pump variation of flow is effected by changing the position of a sliding block. By raising the blocks to give an elliptical shape to the cavity in which the blades rotate the oil will be pumped according to the amount of space between the rotor and the block. In the double type pump shown in the illustration the right side is fixed flow and the left is variable. This double feature, however, is not incorporated in all pumps.



TANDEM-DRIVEN Waterbury pumps in the base of a Hutto grinder furnish power for spindle rotation and feed

It is evident that any constant-delivery pump can be made to give a variable delivery by varying its speed. Variable-speed driving units and different types of speed-changing devices sometimes are employed for this purpose. The pumps themselves are identical with the constant-delivery types to be treated in succeeding articles.



IN DESIGNING the Navy airship Akron, special apparatus was developed to assemble it. The craft is 785 ft. in length, expected to carry 182,000 lb. of useful load with a cruising speed of 50 m.p.h. and range of 9,200 miles

Trends in Product Design

OVERWEIGHT to a total of about 20,000 lb. has brought renewed attention to the mechanical design of the naval dirigible Akron. Excess weight is penalized at $5 per pound, and bonuses were offered for weight saving on equipment which most companies were able to meet. The special gas-electric plants designed and built by the Universal Motor Company for supplying 11,000 watts of power weighs only 470 lb. The 4-cylinder motor, built of strong aluminum alloys and cadmium-plated parts, runs at 4,500 r.p.m. The radio equipment built by Westinghouse with particular attention to design details and use of light material, weighs only 1,000 lb., although a maximum of 1,400 was allowed. Other equipment was also specially designed. The cooking range is of aluminum alloys, bronze, and nickel, and weighs only 110 pounds.

AMONG TEXTILE machines is a ring spinning frame developed by Hartman, Germany, that will produce finished yarn directly from the drawing-sliver frame, eliminating three operations and all fly frames. The machine uses two sets of drafting rollers, between which is inserted a small twist tube for condensing the strand. Development of an "STS" gearing system for rotary textile printing machines (Rice, Barton & Fales, Inc.,) eliminates changing of star gears and saves time where frequent changes of pattern are made. It consists of a series of laminated intermediate gears mounted in a segment frame swiveled about the star gear. When the size of the printing rollers is to be changed, the segment is swung so as to mesh the selected intermediate gear with the star gear. Wear testing of carpet is done on a machine mounting a circular sample on a table which may be moved vertically to contact with two leather-covered wheels, one driving the table by friction and the other producing the wear on the fabric.

THE United States Navy is having submarine Diesel engines built at the Navy Yard by duplicating the latest engines built by the M.A.N. Company in Germany, according to L. H. Morrison, in *Power* for July 7. According to the Navy, the American engine builders have not developed approved submarine Diesels. It is pointed out that although there is a very limited market for submarine Diesel engines, there is a broad field for the use of Diesel electric locomotives on main lines. Such engines would have to be of 2,500 hp., be compact, light in weight per hp., high speed, accessible, and reliable. These are the identical characteristics required of submarine Diesels. There is undoubtedly an opportunity for American designers to put forth greater effort to produce large, reliable, high-speed, light Diesel engines. Rear Admiral S. M. Robinson, head of the Navy Department Bureau of Engineering, indicated that the Navy would renew its demand for $3,000,000 from Congress at the next session for experimentation with Diesel engines and to encourage the construction of such engines by com-

mercial builders in this country. It has been claimed that German Diesel engines are of better design and construction than those produced in the United States.

RECENTLY THE Baldwin Locomotive Works completed its oil-electric locomotive No. 61000, powered by a 1,000-hp. Krupp Diesel engine. Designed for switching service, the maximum speed of this locomotive is 25 m.p.h.; the total weight, 270,000 lb., carried on four pairs of drivers, mounted in two articulated four-wheel trucks. The oil engine and electric generator are mounted on a one-piece casting 44 ft. long. Speed of the engine is controlled by means of a hand throttle, from an idling speed of 250 r.p.m. to a maximum speed of 500 r.p.m. Simultaneous operation of the electric controller and oil-engine throttle is secured by a lever attached to the electric controller shaft and actuating a hydraulic cylinder, which in turn connects to a second hydraulic cylinder and lever, the latter moving a governor cam, thus manipulating the throttle of the engine.

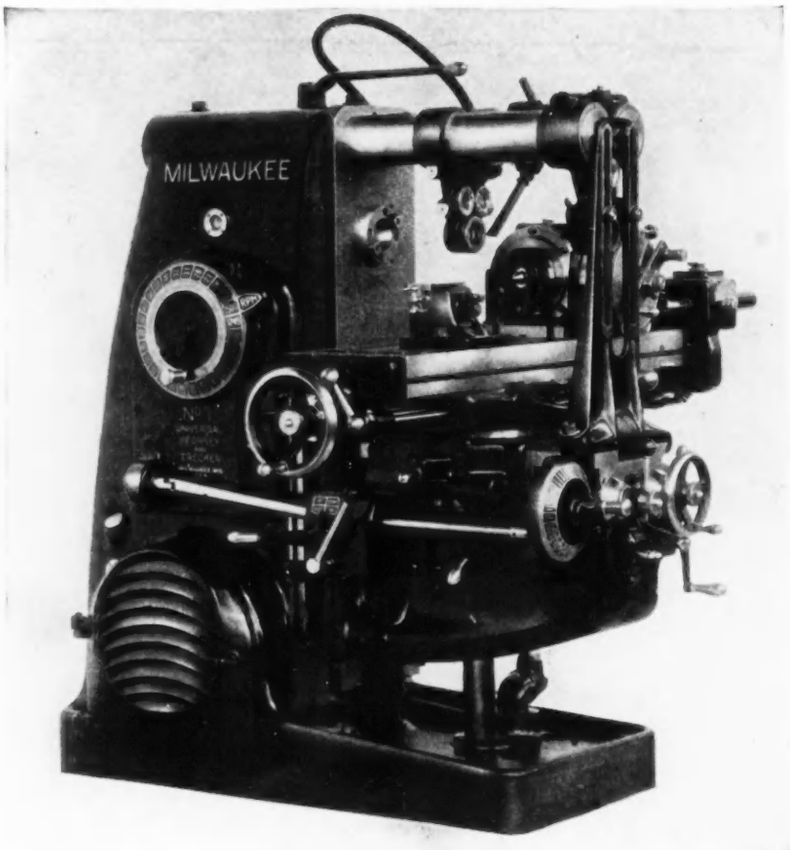
Storage batteries are used for cab lighting, control circuits, and for operating the 2-hp., 1,500-r.p.m. piston-cooling-oil-pump motor for a period of 10 min. after the engine has been stopped.

Air drums with a capacity for 42,000 cu.in. at 355 lb. per sq.in. furnish air for starting the Diesel engine and also provide air-brake pressure when the pressure in the brake reservoirs falls below 115 lb. per sq.in.

Water radiators for engine cooling are located in the back of the locomotive. Two radiators for cooling the lubricating oil are located near the front end. Betz-type fans mounted on the roof of the cab circulate the air through the radiators. These fans are constructed of aluminum alloy and are of eight-blade design, made by Siemens Schuckert.

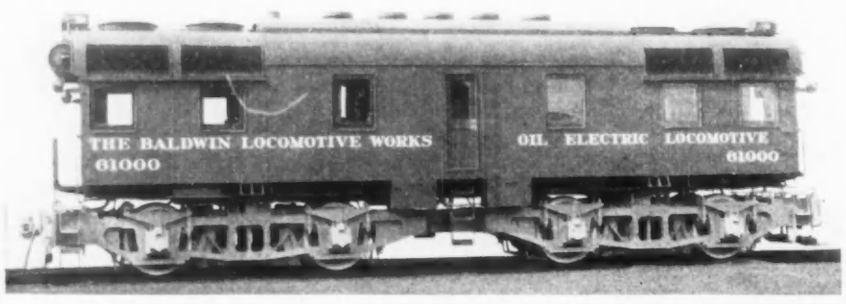
MILLING MACHINES designed by the Kearney & Trecker Corporation have high spindle speeds, up to 1,500 r.p.m., to make use of tungsten- and tantulum-carbide cutters. The 27 speed changes are selected by the large dial on the column. The nine highest speeds are effected by a worm drive, the worm being mounted directly on the spindle. Three anti-friction bearings support the spindle. Spindle driving gears are carried on short multiple-splined shafts carried by anti-friction bearings, which are mounted in a double wall plate. The center arbor support is made in halves to permit removal of the arbor with the cutters intact.

The knee has "sponsons" at the sides and the bottom to give greater rigidity. The V-belt driven sheave is of fan-type construction to ventilate the louvred motor compartment.

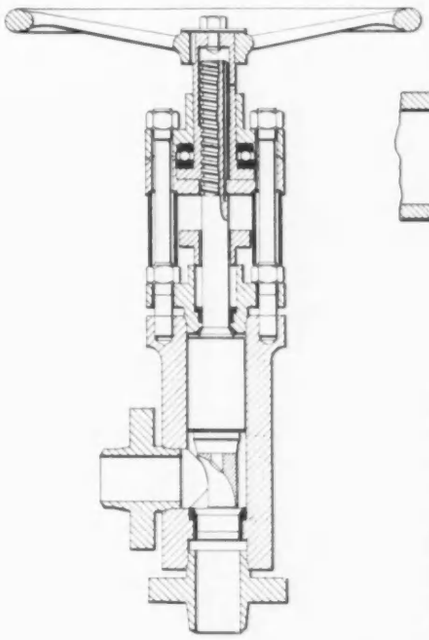


Milling machine for high speed and wide selectivity

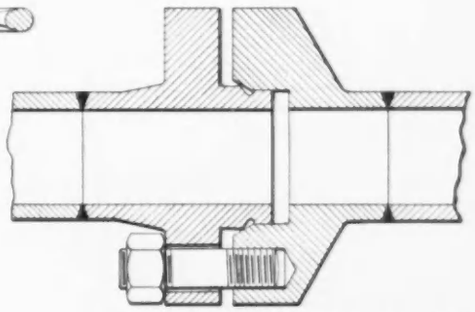
A DOUBLE-PRESSURE three-cylinder locomotive of the oil-burner type, built with the Schmidt method of steam generation for the Canadian Pacific railroad, has a tractive force of 90,000 lb. This locomotive is the first on this continent to utilize the Schmidt system. The weight of the engine is 485,000 lb., and the tender 300,000 lb., a total of 785,000 lb., while length over-all of the two is 90 ft. $2\frac{3}{8}$ in., an increase in weight of 44,800 lb., and an added length of 1 ft. 2 in. over the 5,900 series locomotive, the biggest locomotive prior to the construction of the "8,000." The ten driving wheels are 63 in. in diameter, the two low-pressure cylinders located outside the frame and using superheated steam at 250 lb., pressure per sq.in. are 24 in. in diameter by 30 in. stroke and the high-pressure cylinder, situated between the frame, uses superheated steam at 850 lb., and is $15\frac{1}{2}$ in. in diameter by 28 in. stroke, transmitting its power through a piston and connecting rod to a crank axle located at the second half of driving wheels. The "8,000" is termed a "multi-pressure" locomotive because steam is generated in three different pressures. The firebox and combustion chamber are formed by tubes in which steam at 1,300 or 1,359 lb. is generated from distilled water.



ELECTRICAL merchandise is fruitful with ideas to make housewives part with their money. Two "cordless" electric irons have heating stands to which the cord is plugged, the iron taking heat from the stand and being free from an entangling cord. Electric ranges now combine the range with a worktable and utensils cupboard, and bright colors are chosen. Washing machines feature porcelain inside and out, rounded corners of the tub for easy cleaning, electric water heaters, cadmium-plated parts, rubber-tired casters and automatic lubrication. One model uses a pneumatic water extractor, the air pressure being produced by a compact pump driven directly from the washer mechanism and equipped with an automatic shut-off that operates when the water has been extracted to a certain point. Colored wringer rolls with an irregular design permit the operator to see direction of turning more easily. Any desired color can be had at slightly greater cost than white or black. Waffles—light, medium or dark brown, but not black—can be obtained from an electric waffle iron with adjustable thermostat control.



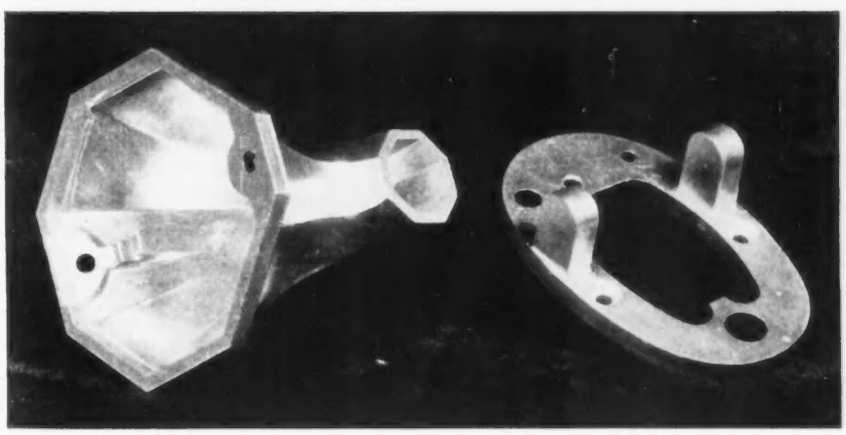
GRAND PIANOS have suffered some decline in popularity with the advent of the radio and the apartment, but one company was recently reported working to capacity making them. The Everett piano has a case designed to appear smaller than it actually is, to give an impression of small size and neat appearance. Price has been kept low consistent with value. The encasement is streamlined, trimmed in contrasting wood, and dust-proof construction being employed. Hardware is of solid brass, treble strings are of chromium-plated rustless steel, bass strings are covered with pure copper wire. Finish is in lacquer, hand rubbed.



HIGH-PRESSURE pipe joint and right-angle valve employing the cone seal principle

INCREASING steam boiler pressures has necessitated the development of an entirely new line of steam valves and fittings. The pipe joints and valve designs here illustrated were developed by the late Prof. Stephan Loeffler. The fundamental principle of this design is shown in the pipe joint. Pressure applied in tightening the joint squeezes the edge of the inner cone into the hollow cone and when subjected to internal pressure, the inner cone is deformed, producing a hermetic seal.

Application of this principle of design to right-angle valves is shown in the other illustration. The valve housing is cut from a solid block of steel, and the pipe connections are made by the high-pressure flange joints described. The tubular extension of the flange is beveled for welding to the connecting pipe. Another interesting feature of the design of this valve is the application of ball bearings.



BRASS die castings with tensile strength up to 70,000 lb. per sq. in., requiring no machining, are now being produced.. The above parts made by Doehler are representative

An electric fan uses a phenolic molding compound for the case and pedestal, set off by cadmium-plated metal parts, and radio interference is done away with by a shading-ring induction motor with a squirrel-cage rotor, but with no commutator or slip rings. Operating a television disk or drum exactly in step with the sending station is the function of a new synchronous, condenser-type motor with a special starting hook-up. Manufacturers are standardizing on 1,200 r.p.m. for this service.

AUTOMOBILE designers are hard at work on changes that will not only bring new features into cars coming out this fall, but also will eventually result to radical changes to the whole design structure of the automobile. A summary of this situation is given in a separate article on page 373.

COLD-MOLDED plastics have recently found a new lease of life because of great improvements in molding technique that have made possible stronger and better-looking products than were available with the older cold-molded materials. Cast plastics also constitute a very recent development, and several brands are now on the market. The latest development in molding plastics is a condensation product, "Sakaloid," using sugar in place of phenol. Polymerization of sugar with formaldehyde under heat and pressure has produced a molding resin that is highly transparent, non-inflammable, and capable of being produced in any color with dyes or pigments. The advantage of sugar over phenol is its low price, sugar being at the present time one of the cheapest chemically pure organic materials on the market. It is too early to judge the relative merits of the new material. The carbohydrate products have certain disadvantages, but have such advantages as transparency and low cost.

PROJECTION METHOD for calculating dimensions

When the designer must locate points with reference to other than horizontal and vertical axes, or determine unknown lengths and angles of elements in a closed system of linkages, he need solve only simple first-degree equations, explains A. R. Kligman, designing engineer, Kier Castype Corporation, the author of this article. The usual triangulation method leads to cumbersome figures and inaccuracies

WHEN the assumed data in the design of a machine have been established, series of calculations are usually performed in order to determine dimensions both within important members individually and between them as groups, so that the parts, when made, will go together and function as intended. Such calculations are simple if the chain of parts making up the mechanism is such that the dimensions follow two major reference lines, usually horizontal and vertical.

Ordinarily, however, this is not the case. At least some of the links in the chain of parts will depart from this orientation, or the elements of a specific line may be so positioned that they make a particular configuration. A geometrical analysis and the computation of all its essential elements then becomes necessary. The problems presented can be, and usually are, solved in this manner, but when elementary triangulation of the layout is the only means employed, a great amount of time is consumed and accuracy is sacrificed.

Solution of such problems can be obtained readily by the method of projection. Referring to Fig. 1, the basis of this method is the evident truth that the projections of any two broken lines such as $A_1A_2A_3B$ and $A_1A_4A_5B$, joining the two points A_1 and B on any fixed base line MM_1, are equal. This statement takes into consideration the direction of the projections along the line MM_1, projections in one direction being assumed as positive, and those from the other direction as negative. Thus in figure, the projection of a_5b of A_5B may be taken as negative, while the remainder, a_1a_2, a_2a_3, a_3b, a_1a_4, and a_4a_5, are positive, or the signs may be reversed.

Now if the directions of all the segments in these two broken lines with respect to MM_1 are known, that is, if the angles α_1, α_2, α_3, α_4 and α_5, are given, and the length of all segments but one are also known, then the unknown length may readily be determined. Assuming that A_4A_5 or l_4, as designated in Fig. 1, is the unknown quantity, it may be found through the equation:

$$l_1 \cos \alpha_1 + l_2 \cos \alpha_2 + l_3 \cos \alpha_3 = l_1' \cos \alpha_1' + l_4 \cos \alpha_4 - l_5 \cos \alpha_5$$

From which

$$l_1 = (l_1' \cos \alpha_1' + l_2 \cos \alpha_2 + l_3 \cos \alpha_3 - l_1' \cos \alpha_1' + l_5 \cos \alpha_5)/\cos \alpha_1$$

This equation holds true regardless of the angular position of the projection line MM_1, and whichever direction on this line is taken for positive. Reversing the signs of the direction merely results in reversing all of the signs of the terms in the above equation.

In applying the above fundamental equation, the angular direction of MM_1 is chosen so as to lead to a solution in the shortest possible way. In some cases the direction may be made to coincide with some one of the segments, and in other cases it may be made to be at right angles with one of the segments. This last method is a convenient way to eliminate one of the unknown elements from the equation when the length of two of the segments is not known, because the

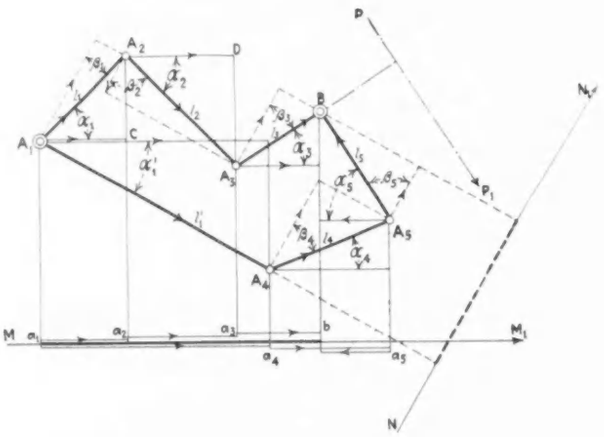


Fig. 1—Projections on any base line of the two series of broken lines extending from A_1 to B are equal to each other, the individual projections being considered positive or negative depending on the direction of the projection

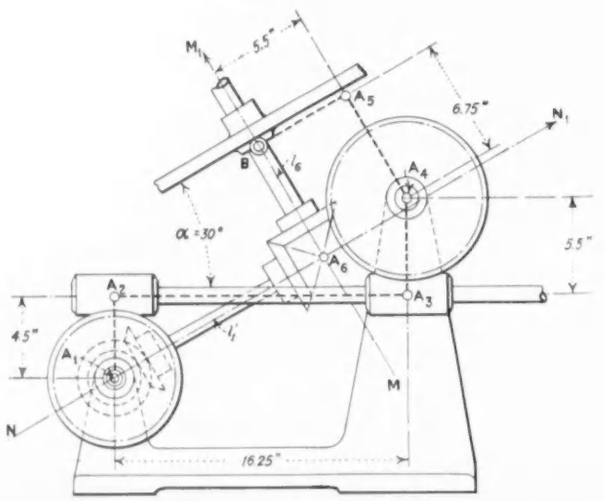


Fig. 2—Calculating the location of the apex of a pair of bevel gears by means of the projection method

projection of the segment perpendicular to the base line becomes zero. As an example, assume that segments l_3 and l_1' in Fig. 1 were unknown. The lengths of the others and the directions of all are given. Then taking the base line NN_1 perpendicular to l_1' we get:

$$l_1 \cos \beta_1 - l_2 \cos \beta_2 + l_3 \cos \beta_3 = l_4 \cos \beta_4 + l_5 \cos \beta_5$$

Only one unknown, namely l_3 enters into this equation and therefore the unknown quantity may be solved for readily. To solve for the other unknown quantity, l_1', the broken lines may be projected upon any other base line such as PP_1, preferably taken perpendicular to l_3, as this last will give an equation containing only one unknown.

When changing the angularity of the base line with respect to the linkages, it is of course necessary to compute the new directional angles for all of the segments. If the direction of one of the segments is the only unknown factor it is quite evident that in the above equation the unknown quantity will be one of the angles, alpha, instead of the length of the link. The above equation taken for any direction of the base line will then contain only one unknown, namely, the angle to be found.

If the length of one segment and the direction of another are the unknown elements, the above equation, applied to a projection line perpendicular to the segment of unknown length but known direction, will determine the unknown angle. Setting up the equation for any other convenient direction of base line will then determine the unknown length.

In a practical application of this method, it is not necessary to draw all of the right-angle triangles such as shown in Fig. 1. The essential steps are:

1. In determining the plus or minus sign for each projection, progress in tracing projections of both broken lines must be from the same starting point and toward the same terminal point of each of the two series of linkages.
2. The projection of a segment of length u on a base line making an angle alpha with it is equal to $u \cos \alpha$, and becomes u when $\alpha = 0$ and equals 0 when $\alpha = 90$ deg.
3. Projection of a segment of length v and at right angles with the previously mentioned segment u is equal to $v \sin \alpha$, since the angle α is complementary to the angle that the segment v makes with the direction of projection.

In Fig. 2 is presented a chain of parts in a machine consisting of two trains of gearing in two different planes parallel with the plane of the paper. In one plane there are two worm gears A_1 and A_4 driven by worms A_2 and A_3 that are mounted on a common shaft. In the other plane are two pairs of bevel gears transmitting movement from shaft A_1 to shaft B. The dimensions and angles are given in the figure. It is necessary to find the lengths l_1' of segment A_1A_6 and l_6 of segment A_6B, the two lengths being at right angles to each other.

Taking A_1 and B as the terminal points of two broken lines A_1A_6B and $A_1A_2A_3A_4A_5B$, and projecting upon the base line MM_1 we get:

$$l_6 = 4.5 \cos 30 - 16.25 \sin 30 + 5.5 \cos 30 + 6.75$$
$$l_6 = 7.285.$$

Next taking NN_1 as the base line to project upon:

$$l_1' = 4.5 \sin 30 + 16.25 \cos 30 + 5.5 \sin 30 - 5.5$$
$$l_1' = 13.573.$$

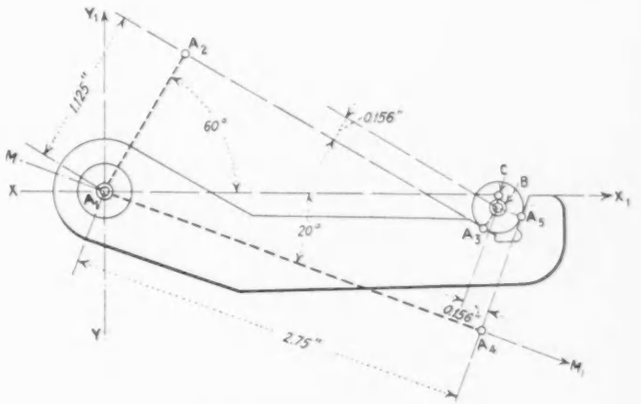


Fig. 3—Showing how the position of the center *B* with respect to the axes *X* and *Y* can be calculated

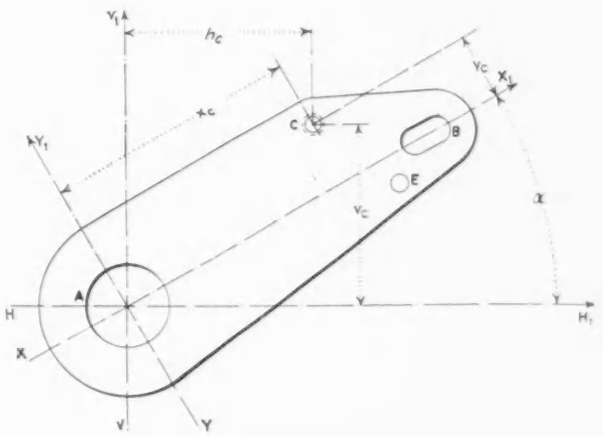


Fig. 4—The projection method provides a simple means for relocating the points with respect to a different set of axes

To illustrate another type of problem, Fig. 3 shows a detail of a pawl that has two faces A_2A_3 and A_4A_5 ground accurately as to their directions with the reference line XX_1 and as to their distances from the pivot A_1. It is desired to determine the position of contact pin B of a given diameter in the system XX_1——YY_1 to which the detail is referred. That is, it is desired to find the lengths A_1C and CB. As shown in the figure, the points A_1 and B may be joined by three series of broken lines, namely,

(1) A_1CB (2) $A_1A_2A_3B$ (3) $A_1A_4A_5B$

The first of these series involves two unknown lengths. The other two series of broken lines include only one segment of unknown length in each of them. The unknown lines are designated in the figure by light broken lines. Considering the last two series of broken lines and projecting them both on the base line MM_1:

$$A_1A_2 \cos A_2A_1A_4 + A_2A_3 \sin A_2A_1A_4 + A_3B \cos A_2A_1A_4 = A_1A_4 - A_5B$$

Solving the above equation by substituting the quantities designated in the figure we get:

$$A_2A_3 = 2.408.$$

With all of the elements of the broken line $A_1A_2A_3B$

known, it may be paired with the line A_1CB and two lines then projected on the perpendicular axes XX_1 and YY_1 respectively, the axis XX_1 coinciding in direction with the line A_1C. Thus:

$$A_1C = A_1A_2\cos 60 + A_2A_3\sin 60 + A_3B\cos 60$$
$$-CB = A_1A_2\cos 30 - A_2A_3\sin 30 + A_3B\cos 30$$

These equations may be solved readily by substituting the quantities as designated in the figure, which gives:

$$A_1C = 2.726$$
$$CB = 0.095.$$

The point B is thus accurately located along the X and Y axes, with respect to A_1, the origin of the axes.

An important and frequently occurring problem which is a particular case of the general problem stated above, is the re-dimensioning of parts to accommodate a change in the angular direction of the reference lines. Such a problem can be solved by means of individual triangulation. This requires that for every point to be relocated there are a relatively large number of computations involved, including square and extracting roots, trigonometric computations, and similar operations. By applying the projection method described here only two equations are involved in determining the relocation of any points. These transformation-of-coordinates formulas, as they are called in the courses in analytical geometry, are general and apply to any point in a detail. Thus, referring to Fig. 4 we have the following equations for relocating the point C with respect to axes XX_1 and YY_1, the axes VV_1 and HH_1 being the original axes.

$$x_c = h_c\cos\alpha + V_c\sin\alpha$$
$$y_c = h_c\sin\alpha + V_c\cos\alpha$$

These formulas provide a direct way to calculate the dimensions to the new reference axes and do not involve calculations of any extra elements. The angle α being the same for all points of the same detail, the value of $\sin\alpha$ and $\cos\alpha$ need be calculated only once. Performing the computations on a calculating machine, any degree of accuracy can be obtained easily. The facility of this method as compared with the cumbersome and tedious method of triangulation is self-evident.

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BOOKS FOR ENGINEERS

MECHANICAL DRAWING, BOOKS I AND II. *By Horace E. Boggy, Head of the Drafting Department, Arsenal Technical Schools, Indianapolis. Pages 8½x11 in.; Book I, 48; Book II, 32. Paper covers. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Price $0.60 each.*

UNUSUAL in this set of elementary drawing texts is the effort to have the student understand the ultimate function of the part which he is drawing, its relation to other parts in the assembly, and the reasons for being required to draw it. The texts consist of groups of practical drawing problems, each group being the same in principle but graduated in difficulty. This graduation permits the instructor to assign problems to students on a basis of their comparative ability. Pictures, drawings, and design data regarding modern engineering structures are included.

MECHANICAL LABORATORY METHODS. FOURTH EDITION. *By Julian C. Smallwood and Frederic W. Keator, Assistant professors of mechanical engineering, Johns Hopkins and Yale Universities, respectively. 386 pages, 6x9 in. Indexed. Appendixed. 121 illustrations. Clothboard covers. Published by the D. Van Nostrand Company, Inc., 250 Fourth Ave., New York, N. Y. Price $3.50.*

THE art of experimental measurement in mechanical engineering has progressed rapidly in recent years. New instruments of greater precision have been developed. Old standards for test results have been refined, and in some cases, quite different ones established. A thorough rearrangement and revision of this standard text has, therefore, been made to meet modern requirements. Much old material has been omitted. Most of the remaining sections have been rewritten, and new tests added. Recent standards established by the A.S.M.E. have been followed and reference given to test codes.

CHEMISTRY OF ENGINEERING MATERIALS. *By Robert B. Leighou, professor of chemistry, Carnegie Institute of Technology. 684 pages, 5½x8 in. Indexed. Clothboard covers. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Price $4.50.*

THIS third edition of a book that has been a standard text since 1917 incorporates new developments and new uses of materials. The metallurgical processes of all the metals have been described more extensively, and certain metals such as magnesium and cadmium have been added to the industrial group.

The book is primarily a college text in the chemistry of materials, but for any engineer who desires a concise review of the background of the subject it is especially valuable. Some of the general chapter headings are: Iron and steel; fuels; non-ferrous metals; foundry sands; lime and gypsum products; portland and other cements; paints, varnishes, stains, and fillers. It is subject paragraphed for convenient study, and well arranged.

APPLIED KINEMATICS. *By J. Harland Billings, B.A. Sc.,S.M., professor of mechanical engineering, Drexel Institute. 173 pages, 6x9 in. Indexed. 154 illustrations. Problems. Clothboard covers. Published by the D. Van Nostrand Company, Inc., 250 Fourth Ave., New York, N. Y. Price $2.50.*

WHILE the theory of mechanism and the principles of kinematics have not changed greatly in the past two decades, there has been a marked shift in the relative importance of their applications. The applications chosen by this author to illustrate and anchor principles have been selected to assist the instructor in making the study of this subject an applied engineering course. The graphical method is freely used, correlated with analytical methods where the author deemed it advisable.

Prominence is given in the book to the treatment of acceleration in accordance with the present trend toward higher speeds in machines.

Modern Form in Design

By SIDNEY G. WARNER

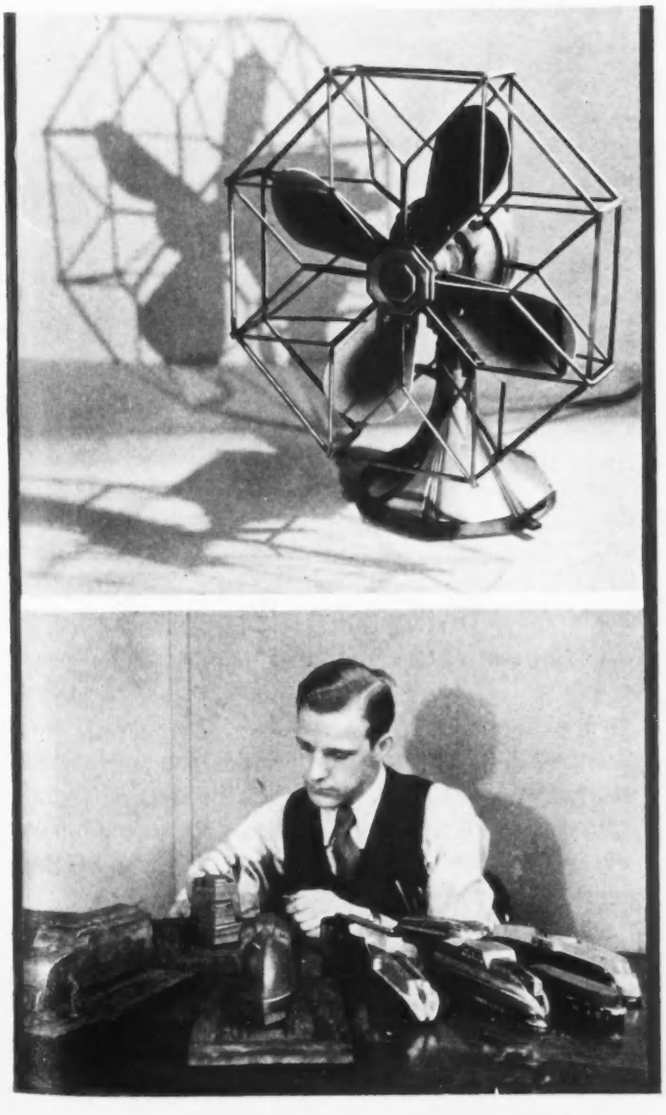
Art Division, Engineering Department, Westinghouse Electric & Manufacturing Company

IN AN effort to extricate himself from false fetters, and to bring about honest, logical design, the present day designer takes for his creed: "Form follows function." By this creed the roundness of all design in the structural and applied art fields may be tested. To this principle there must be added two important corollaries. First, an object should not disguise the basic principle of its construction. Second, it should not disguise the materials of which it is made. That these principles of modern design are revolutionary can readily be seen, particularly in their influence on the method of approach. In the past, form and ornament have been considered as all important; function and structure were subordinated. Confused and elaborated ornament was good taste in art. Complexity rather than simplicity ruled and domineered. For this reason, the old art as applied to modern products was degenerate, dishonest, and lacking in character.

As Raymond Hood claims, it is against this despotic sway that modern art in product design has risen in revolt, and it is not because the old rules of color harmony, good proportion, unity, and composition must be discarded. Modern art involves a sincere attempt to be honest with itself. If a man wants a chair, he isn't given a clumsy, uncomfortable thing. If the glare of a light hurts the eyes, the customer is not told that his eyes are weak, the fixture is redesigned. A product should not be an over-elaborated and ornamented expression of unthinking designers. In other words, its function should dictate its form and design.

Briefly, the contemporary artist reverses the philosophy of the past century when the ironclad rules of art and beauty came first and utility followed along as best it could. Today, utility comes foremost, and although the present results may not be aesthetically perfect, they nevertheless satisfy the logical intellect. Every age has had its artists and craftsmen who worked as honestly as the sincere and enlightened artists are working today, but frequently craftsmanship and utility was subservient to ornamental art. Honesty in design is a necessary attribute of beauty.

Lewis Mumford, a short time ago, had this to say about the machine and its products: "Since economy is the source of all that is beautiful in machine work, and since economy means simplicity and sincerity in design, these



MODERN design in a fan. Clay models are employed for visualizing stream-lining in electric locomotives

efforts to achieve extraneous beauties and superfluities result in so much gratuitous ugliness." He goes on to say that a pecuniary culture wants, not beauty or fine workmanship but conspicuous waste. Because the beauty of a machine product is not so costly, it is shunned and neglected. But for this very reason it is bringing about a universal art, an art for the many, not for the few, and fitting for this machine age.

The underlying essentials of modern design when boiled down, then, are:

1. That function should determine the form,
2. That honesty and fitness to purpose of the design are of paramount importance,
3. That simplicity and directness of effort and approach should guide the artist,
4. That the use of materials should be economic and logical.

With these weapons the contemporary designer combats the old ideas of conspicuous waste, of superficial ornamentation, and exaggerated grandeur. These essentials when used in combination with the age-old principles of art and design will consummate in a new conception of beauty. What are these art principles?

It has been said that good design is the art of making useful things beautiful. In other words good design is the intention to synchronize utility and beauty.

It is as scientific as engineering, and likewise is based on a knowledge of definite age-old principles. These fundamental principles of art and design, which contribute to beauty, have always remained constant. A few of the more important principles may be noted, such as, symmetry or balance, transition or flow, apposition, and repetition or sequence. Every great piece of art whether in literature, music, dramatics or architecture is based on these principles. Their embodiment may be perceived in an Egyptian temple, a Grecian vase, a Gothic cathedral, or a Chinese print. Although materials, tools, methods and manners change with different civilization periods, the art principles have never changed. They are beyond man's scope to change. Man instinctively prefers order to disorder and balance to lopsidedness.

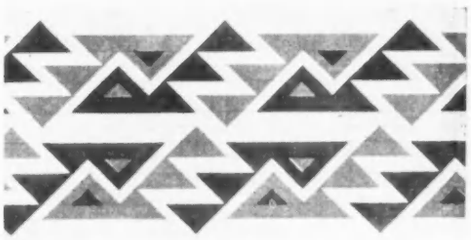
In the application of these principles to two or three dimensional design, the designer is confronted with one or more of the following elements; lines, shapes, (two dimensional), form (three dimensional), value (light and dark), color (hue, value, chroma), and texture. Within the limitations of function, tools and materials, the designer must apply these principles of good design to the elements used. When a thing is produced with an inherent knowledge of these principles, and with the modern attitude of design that "form follows function," that thing will be beautiful. This beauty may take the form of a suspension bridge, stretching sky scraper, lounge chair, tri-motored monoplane, or chromium-plated percolator.

The third dimensional aspect of modern design is important. Clay offers an excellent medium of expression for the artist and engineer. In the first place it is essentially a creative medium, suitable and adaptable to the creative, speculative and plastic mind of the designer. It is perfect for structural designing. Two-dimensional design, that of pencil or pen, is insufficient for the creative mind. The conception of a meter, cover, or loom motor can best be objectified in the third dimensional form. Its advantages are primarily potent.

Clay has a plastic quality which allows for easy manipulation and profound flexibility. It is never permanently set, it can be changed at will. Another advantage, most essential in the conception of an idea, is the concrete visualization of form. A clay model of an electric iron, offers the concrete, exact idea. The three dimensions of the thing show you how it will be in actuality. To visualize this same iron on paper is almost impossible, only part of the picture is presented. With the clay model, however, the iron in its entirety is seen. And further, from the final model, the necessary mold or molds can be ob-

tained for the manufactured product. There is a need for good sound design today in the industrial field. A product must have character, it must be strong in its functionalism, not weak or sloppy, and it must thus be visualized in advance.

In the development of a hand vacuum sweeper, a clay model was designed and executed to insure efficiency of form and beauty of line and proportion. Because the motor frame was to be made of Micarta, a synthetic resinous material, instead of metal, the clay model was exactly duplicated in the final product. Heretofore metal has been used for motor frames, but Micarta was found to be stronger, lighter, therefore better suited. Micarta can be obtained in various colors, whereas metals must be sprayed or painted. Metal must be machined and finished but micarta can be perfectly molded and it carries its own finish.



"The product without art has a value; with art added the product has greatest value."—Marcus Fabius Quintilianus, 70 A. D.

Art is not new, and the straight lines, geometric figures, and simple curves of "modern art" are all from the art primers of the ancients. But the author of this article shows how modern product artists are using age-old art in cooperation with designers to make utility dominate any mere ornament.

Modelling clay also participated in the design of a new loom motor for textile mills. In the case of the new electric fan which we have brought out this spring, the base needed new planes and character. Here again clay figured as a design medium for the base. From the clay model molds were made for the base casting of metal. An octagonal guard breaks with the usual circular shapes; this achieves a marked distinctiveness in the fan. Rather than giving the fan a coat of lacquer, the finish is carried by the brushed metal itself. A recently designed "minatrol" switch is outstanding for its simplicity, mechanical ingenuity, and taste. The carefully modeled handle and line-grooved plate set it apart from anything of its kind. It combines utility and beauty economically and effectively.

In the past, elevator control panels have been heavy, clumsy looking plates of bronze or steel. A new material was sought. Aluminum was found to be better suited, because of its lightness and casting properties, and its adaptability to many varied and interesting finishes. The new metal called for a new design for control panels. Here the artist stepped in, and working in conjunction with the engineer, sculptured out of clay a full size control panel entirely new in conception of design and treatment.

The problem of wind resistance in vehicular transportation is of primary consideration, and right now its study is having an effect on form in vehicles for land and air. Dr. Tietjens, research engineer of the Westinghouse Electric and Manufacturing Company has been carrying on a series of investigations and research work on wind resistance as affected by the shape and contour of different types of high speed vehicles. His work, when completed, should be invaluable to the transportation industry in the consideration of designs, and may, at some future date, result in radical improvements. Modeling clay has been used effectively in the experiments with various contours and streamline effects.

The modern artist-designer is indebted to the engineer, to the scientist and to the inventor. Too long, and too readily has the art of the dead past been dragged into the present, as a means of solving new problems. Such futile attempts show nothing but great laziness and moronic taste. However, designers are realizing the value of the engineers code of functional-form, and directness and simplicity with fitness. By using these new concepts with the old laws or principles of good design, the artist can redeem his past. Honest and round form will eventually materialize in architecture, furniture, lighting fixtures and so on, as it already has very noticeably in the present day motor car.

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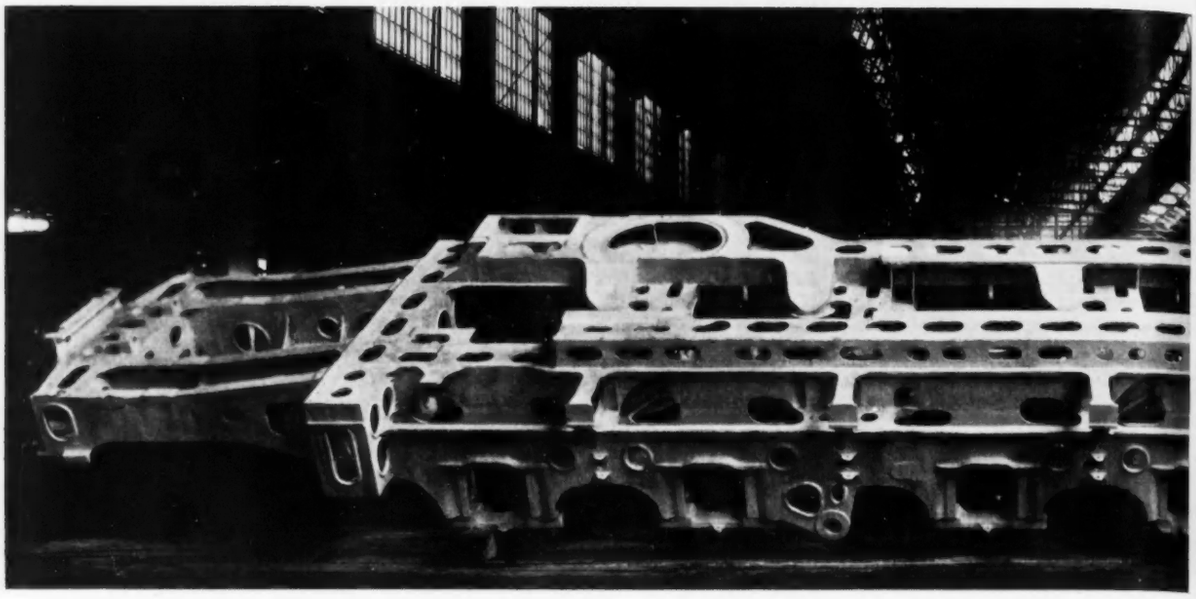


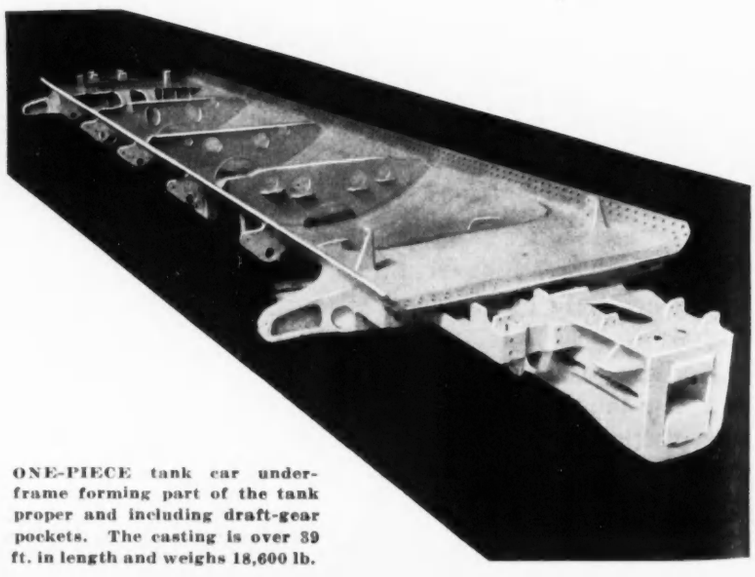
When Designing Steel Castings

By ERNEST E. VEIHL, Jr.
General Steel Castings Corporation

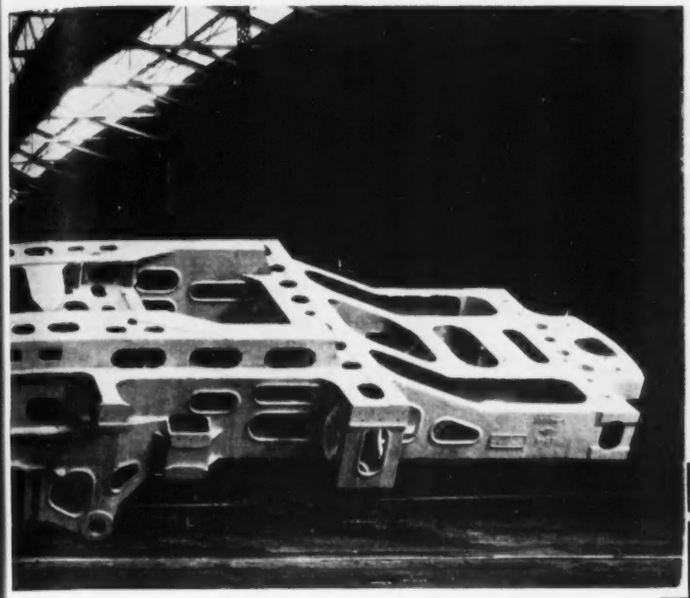
SINCE the turn of the century the use of cast steel has been more and more general, with the railroads, especially those of the United States and Canada, showing the way by the adoption of steel castings for employment on locomotives and cars, both freight and passenger. This fact is doubly significant, inasmuch as railroad rolling stock is subjected to severe service, because of high speed, long runs, heavier trains, and more powerful locomotives.

The mammoth locomotives of today, with their large boilers, high steam pressure, and heavy rail loads, impose stresses on the machinery foundation and on the trucks which in being withstood over long periods of time by a bolted structure, presents a problem to both the operating and maintenance departments of the railroads. Likewise, a built-up truck under a heavy all-steel passenger, sleeping or electrically propelled car, is subjected to vibratory stresses set up by the combination of heavy loads and increased speeds which have been introduced to meet public demand. A bolt in a built-up locomotive frame or truck undergoes an especially severe tension, with the result that stretching occurs. It necessarily follows that constant inspection, tightening, and periodical reaming of the holes and replacement of the bolts are essential if the equipment is to remain in service and safety assured.

The foregoing comments also apply to a riveted structure, inasmuch as the constant vibration and wearing tends to loosen the riveted joints, destroying their efficiency and making necessary replacement which forces equipment out of

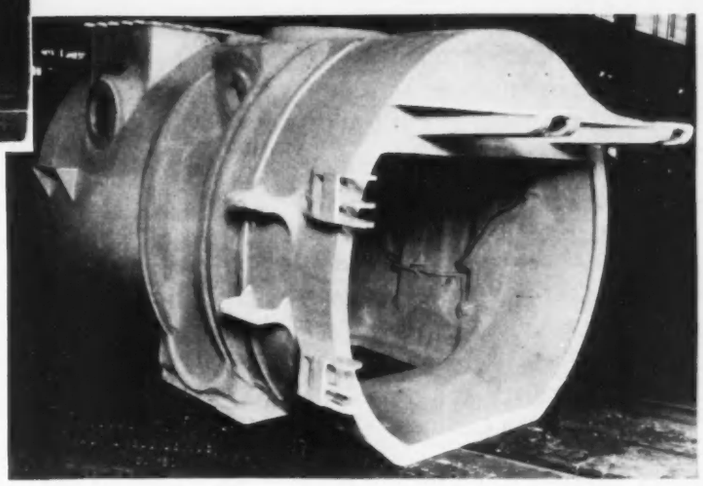


ONE-PIECE tank car underframe forming part of the tank proper and including draft-gear pockets. The casting is over 39 ft. in length and weighs 18,600 lb.



DIESEL-ELECTRIC locomotive bed, considered to be the most intricate and complicated steel casting ever produced for railroad work

CAST-STEEL smoke box to insure a tight chamber and provide rigidity



service. Not only do these loose riveted and bolted joints necessitate constant care and inspection, but they reduce the safety value of the device, a very important factor in our transportation system today.

In order to improve these conditions steel castings were introduced and their satisfactory performance has resulted in their general adoption by every railroad in America. In addition to the great reduction in maintenance costs and accrued losses, due to equipment being out of service, cast-steel unit structures effect further economies.

Foremost of the one-piece castings for railroad service is the so-called "locomotive bed," which serves as the understructure or foundation of the steam or electric locomotive. This type of casting is of recent development, but is now being used under all types of locomotives on practically all the leading railroads of this country and Canada. A casting of this kind is of necessity very complex, and will run into considerable weight on modern railroad equipment. The number of fabricated parts replaced by such a casting is great, as the number of rivets, bolts and nuts required to hold a built-up locomotive understructure together runs into four figures in addition to the parts themselves.

From the viewpoint of the designing engineer, the work of producing complicated steel castings requires much special knowledge. It can be truly said that with a steel casting "metal is placed where metal is needed," or in other words, the metal is placed in the most effective location with due consideration for strength, rigidity, and foundry practices.

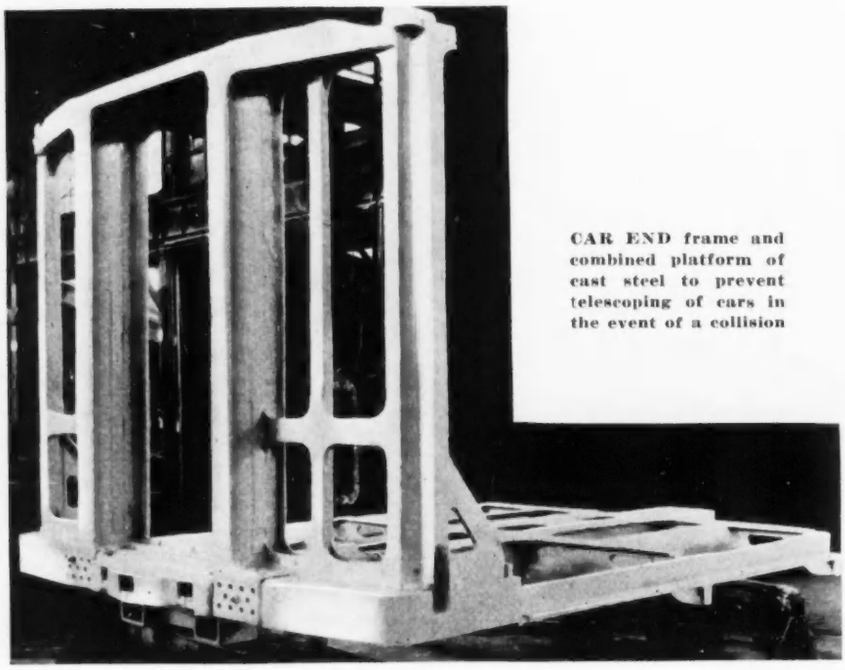
In designing a structure one pertinent feature is that of the constructions of joints and connections which usually determine the strength and rigidity of the whole. These connections, whether they be riveted, bolted, or welded, are points of stress concentration, and it is found that fatigue cracks usually begin at these points of structures subjected to repeated stresses. The elimination of such factors, each of which is a source of weakness and presents difficulties to the designer, is most desirable.

In the earlier designs of steel castings, the fabricated structures that were being replaced were imitated as far as appearance was concerned. However, as the art developed this imitating has been eliminated almost entirely. Designers of cast-steel units today are able to take full advantage of the design flexibility which has been developed by acquired knowledge of the properties of materials.

Some years ago, the late Dean J. B. Johnson, of the College of Engineering of the University of Wisconsin, said that "the rational designing of any kind of construction involves a knowledge of:

1. The external forces to be resisted, transformed or transmitted.

2. The internal stresses resulting therefrom.



CAR END frame and combined platform of cast steel to prevent telescoping of cars in the event of a collision

3. The mechanical properties of the materials to be employed to accomplish the object sought."

He went on to state that the "last item does not rest on any deductive science, as the information can only be gained by patient, expensive, and competent research."

The steel casting designer has recognized the importance of the foregoing essentials with the result that lightness and strength have been combined with artistic form in producing castings which are not only strong and efficient, but also pleasing to the eye. In the early development of steel castings, these essentials were not generally recognized, but more recently the designer and foundryman have coordinated their efforts with the result that simple, durable, strong, and efficient castings have been obtained.

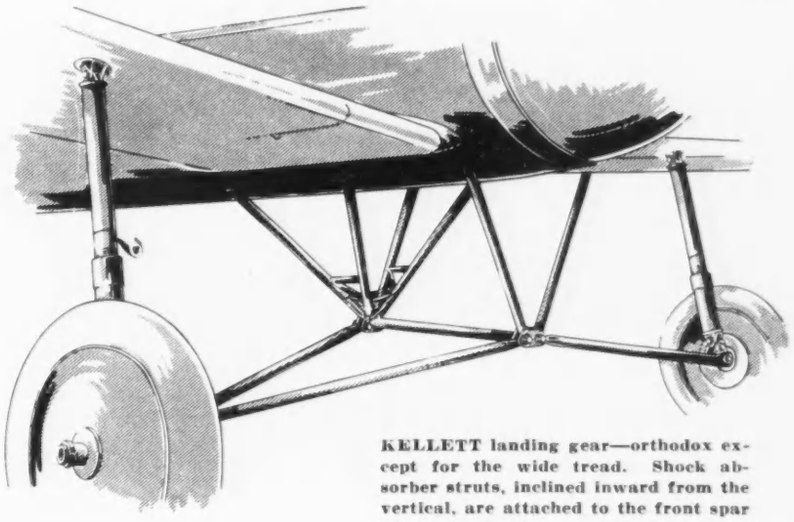
The designing engineer, in a large measure, is responsible for the production of good steel castings. A careful study over a period of years indicates that many of the difficulties encountered in the manufacture of steel castings, or the defects as later developed in service, could have been eliminated by changes or improvements in design. It has also been found that modifications to the manufacturing process could have prevented all but a slight percentage of the remaining defects. While there is unquestionably an opportunity for the improvement of steel castings along metallurgical lines, still experience has definitely indicated that good engineering design and correct manufacturing practice are primarily the first requisites for obtaining high-quality steel castings. It is increasingly evident that the designer takes the initial step toward procuring a good or poor steel casting.

Very complicated shapes may be cast in steel as readily as the more simple ones. Webs, pockets, bosses, or cored holes do not in themselves make it difficult or impossible to obtain a sound casting, but it is of greatest importance that the distribution of metal in the casting be such as to permit the proper feeding of molten metal. Here the third point of Dean Johnson's facts of design must be borne in mind, since no one without a thorough knowledge of the "mechanical properties" of the material to be employed can expect to distribute metal successfully to overcome the foundry "hazards" which exist in the production of steel castings.

There are a great many factors to be considered and remembered when designing steel castings; for example, care must be exercised in the location of lugs and bosses or other heavy portions of metal and their size must be in such relation to the surrounding metal that shrink holes will not develop in or around them. The designer can obtain a good design and more readily insure good foundry results by providing a smoothness of contour and proper blending of metal thicknesses together with the placement of metal in its most efficient position so far as the section modulus or value of each section is concerned. In addition there are further factors which must not be overlooked, because of the generation of greater gas pressures in the mold and increased shrinkage, caused by the inert qualities of the metal and the higher pouring temperatures. No definite unalterable rules of design can be established, but the designer must remember that the molten metal is distributed through the channels of the mold which are later matrices for the casting.

The steel casting business is not unlike the automotive and radio industries of today, as it is constantly changing in order to give the public benefit of new discoveries and developments. The result of the foregoing will then be such as will promote sound castings which may be produced on a commercial basis.

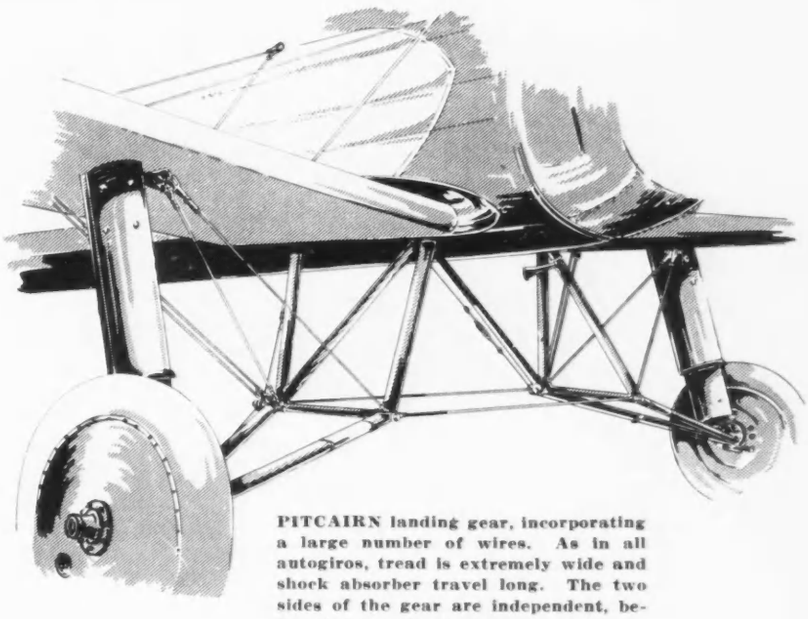
Autogiro Design Elements



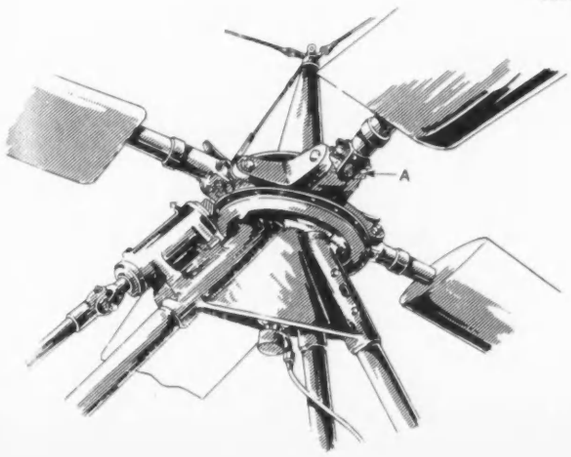
KELLETT landing gear—orthodox except for the wide tread. Shock absorber struts, inclined inward from the vertical, are attached to the front spar of the fixed wing. No wires are used

NO longer is the autogiro a mechanical oddity; it is a commercial product. Three types are now in manufacture in this country, two by Pitcairn and the third by Kellett, described in the July number of *Product Engineering*. Contrary to the usual opinion, the autogiro is not an "airplane in a continuous flat spin." The position, attitude and proportioning of the parts of the rotor must be determined with the greatest care, and the small fixed wings with upturned tips which extend from the bottom of the fuselage are essential to proper operation. The rotor blades, contrary to opinion, are never stalled except on their innermost portions. The effective parts of the blade work for all flight speeds and conditions within a very narrow range of angles of attack.

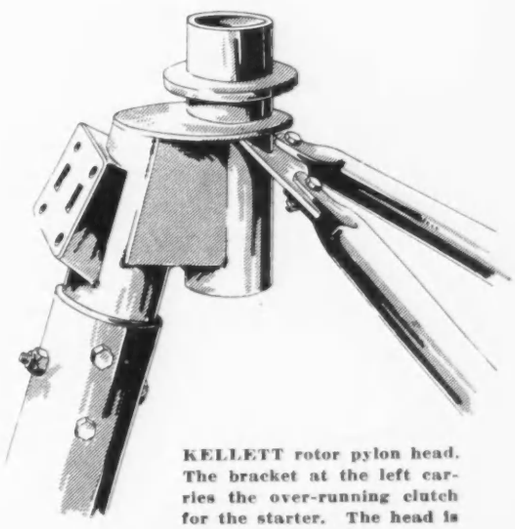
Autogiro fuselages are shorter, lower longerons are straight, vertical tail surfaces have small height. Other changes are made principally for rotor clearance. The rotor blades are hinged at the hub and held up while at rest by suspension cables, but while in flight are positioned only by centrifugal force, their joint with the hub being universal.



PITCAIRN landing gear, incorporating a large number of wires. As in all autogiros, tread is extremely wide and shock absorber travel long. The two sides of the gear are independent, being tied together only by two streamline wires



ROTOR hub and mounting on the Kinner-engined Pitcairn. Rubber locks restraining rotation of the blade around the vertical hinge pin are inserted at *A*



KELLETT rotor pylon head. The bracket at the left carries the over-running clutch for the starter. The head is built up by welding, and is like that of an automobile with separate torque tube

How are your Special Designs

H. A. TOULMIN, JR.
Toulmin & Toulmin

CONTRIBUTORY infringement is one of the most costly occurrences in the manufacturing business. Every engineering department is facing this problem to an increasing degree because of the present manufacturing trend of furnishing unit assemblies or semi-fabricated parts which are later incorporated by others into complete structures. For instance, in a boiler combination, one manufacturer furnishes a motor, another a valve, another a boiler, and another a stoker, and still another a thermostatic control. In the end there may be a complete combination as supplied to the purchaser, but each one of those manufacturers is responsible as a contributory infringer if an element of the combination completes an infringing combination.

Where a defendant admits the manufacture and sale of a single part of a patented combination made up of several parts, and it is shown that the part he furnishes would not have any commercial use except as a part of the combination, the manufacturer of the single unpatented part is guilty of contributory infringement, just as if he made the entire combination of parts.

Take the case of electric motors. One of the large companies furnished a motor that could only be used in the practice of the method of transmission of power specified by the purchaser. The court said that the manufacturer, having furnished the special motor, which only had its usefulness in the particular process belonging to another, was equally guilty with the latter in practicing the patented method of transmitting power. Consequently, the motor manufacturer was a contributory infringer.

Another case involved the use of an electric motor as an element of a combination made in the United States and assembled abroad. In this case, the manufacturer shipped an electric motor into Canada to a customer, there to be placed with the remainder of a combination which had been made by another manufacturer and shipped into Canada. It was proved that the motor manufacturer sold the motor with intent that it should be used with the combination that infringed a patent covering a group of mechanical elements one of which was a motor to operate them.

In the case of shipping one of the elements out of the United States into a foreign country, where the United States patent did not control the making or selling of a single element of a combination, such as an electric motor, it was held not to be an infringement of the United States patent on the combination and was not an act of contributory infringement.

The United States patent did not extend to Canada. The motor would have to be used in the United States with the infringing combination with the intent that it should be so used in order to be contributory infringement of the United States patent.

Take the case of an engineering department designing a special machine that in itself does not infringe any patent, but is to be used as a means of carrying out a patented process. Will the manufacture of that machine be held to be an infringer of the patent on the process?

A case arose in New York where a patent on a process of manufacturing cigars was at issue. A manufacturer of cigar-making machines, with knowledge of the process patent, supplied cigar-making machines to practice some of the steps in the process. The process covered the supplying of a wrapper around the fillers and holding the wrapper by air pressure and gradually rolling it around the wrapper, the unrolled portion being held to a table by air pressure.

It was held that this supplying of a machine with intent that it should be used as a part of the process was contributory infringement.

Generally speaking, a manufacturer who makes and sells an apparatus adapted and intended for no other use than that described in a certain patent, whether it be a mechanical patent or a process patent, is a contributory infringer. That manufacturer is equally liable with the ultimate user. A designer, therefore, to protect his company, should know where his special machine, special motor, or other unit is to be used.

Used?

SUPPOSE that you develop a special machine—your own design and perfectly original with you as a separate unit—but the customer uses it in infringing on a patented process; are you liable?

Contributory infringement is defined as "the intentional aiding of one person by another in the unlawful making or selling or using of a patented invention." This contributory infringing act is usually performed by making or selling part of a patented invention with the intent and purpose that it shall be assembled with other parts that will constitute the complete infringing combination.

Of course, one making and selling a machine particularly designed for the incorporation therein of a patented device, is a contributory infringer even though the placing of the device on the machine is done by another. However, if the machine so supplied is adapted to other uses, the maker of it is not liable if another places it in an infringing combination of his own accord. This protects the manufacturer of standard motors and other units from inadvertent infringement.

Such a case arose where the defendant manufactured an attachment for scales, which did not necessarily have to be used in the patented scale in question. This attachment was an article of commerce and had been sold generally for use on various types of scales, both patented and unpatented. A user of a non-infringing scale took this attachment and placed it on his scale and thereby made it an infringing scale. Suit was brought by the patentee against the manufacturer of the attachment. The court decided that in such a case, as the attachment was one of general commerce, there was no provable intention of supplying it for the purpose of making up the combination, and that there was no contributory infringement.

When can an owner of a patent hold for contributory infringement one who supplies materials that are used in the patented combination? This opens the door to interesting ramifications among contributory infringement rules.

Along this same line a case arose where patents were owned on machines for applying buttons to shoes. These machines were rented under license to shoe manufacturers. A certain commercial form of wire was supplied for attaching the buttons to the shoes, such wires being used in this patented machine.

An agent of another company came along and supplied this wire to users of these machines. It was held that such supplier was a contributory infringer because he knew of the restriction on the purchase of wire, and that the wire was put up on spools in a form that could only be used in those machines, although the wire itself was a common article of commerce.

In the case of a patent on phonograph records, the owner of a patent on the combination of a phonograph record and a phonograph was able to stop infringers from supplying records to those who purchased machines from the owner of the patent, even though the phonograph records in themselves were not capable of being patented. The supply of those records by the patentee to his users was a part of his monopoly.

Certain rules of precaution should be followed by every engineering department of a plant designing or specifying equipment that is to go into various types of machines and processes:

1. If the equipment is designed especially to fit a particular installation or a particular machine, the purchaser should guarantee the seller against infringement charges.

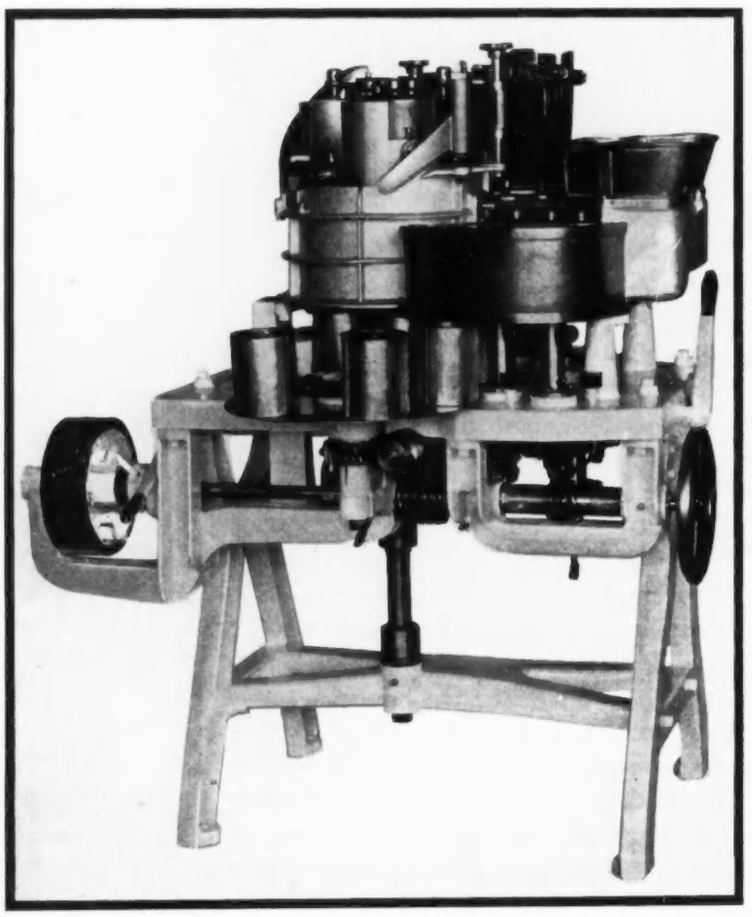
2. If the machine is to go into a patented process, the purchaser should guarantee the supplier against the consequences of patent infringement.

3. If such guarantees cannot be secured or it is impractical to ask for them, then a check should be made to determine whether there will be any contributory infringement.

4. Before supplying units, such as motors, in large quantities for special machines, a careful study of the infringement question should be made, as oftentimes changes in design can be recommended that will avoid all legal troubles.

The Machine Revamps the Process

An Interview with
O. H. HANSEN
President,
Hansen Canning Machinery Corporation

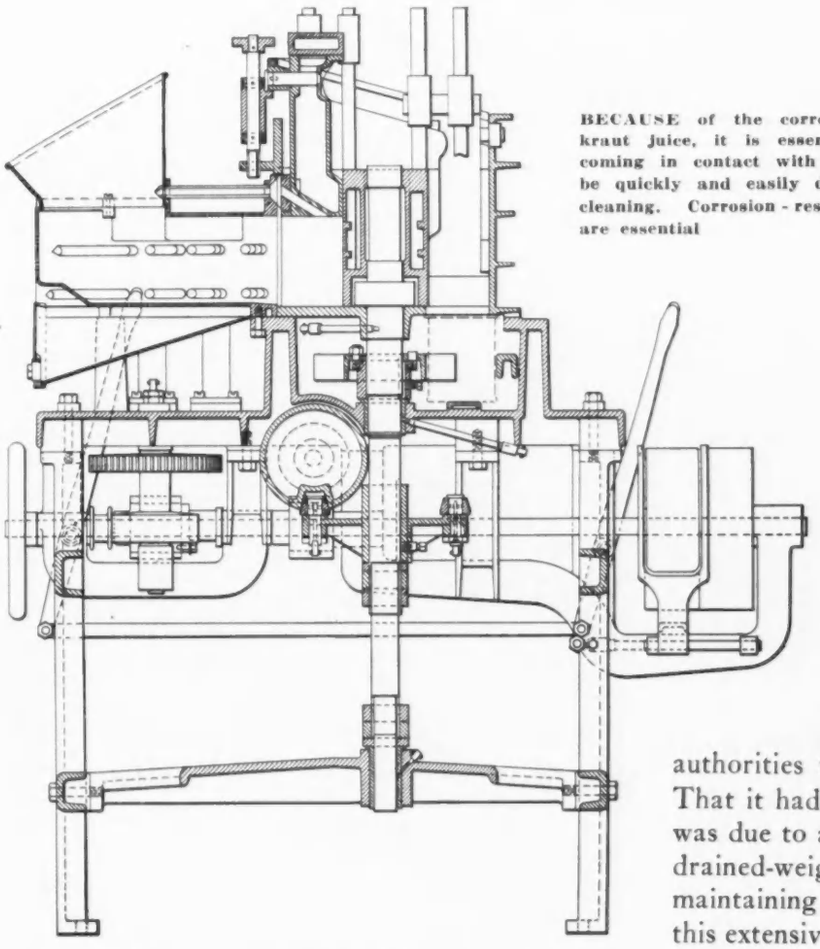


An engineering study of one branch of the canning industry resulted in the substitution of a completely automatic machine for a cheap hand unit and reduced the over-all investment in plant equipment. It proved that expensive automatic units will pay even when used for only two or three months out of the year.

BECAUSE the packing and canning industry is seasonal in character, the first mechanized equipment used was crude in form. Life of the machinery was short, and designers and users alike wese satisfied that "good enough" was best. In recent years manufacturers have adopted corrosion-resistant materials to take care of the inorganic acids present in all kinds of foods, and because of the longer machine life obtained, a better engineered product has been attained. Moreover, it has been found that the more expensive automatic machine pays in spite of the long period of inactivity between seasons.

Representative of the trend is the Hansen kraut filler. The history of the machine is tied up closely with that of this branch of the industry, and the engineering development done is an indication of what can be accomplished by intelligent field studies. Commercial manufacture of sauerkraut dates back to the early eighties, when the cut cabbage was packed into barrels to ferment, the product being practically all marketed in kegs and barrels. About the year 1900 manufacturers began to pack a small part of their output into tins, but the canned kraut was of inferior quality and much of the contents was salt brine.

In 1922, as a result of an advertising campaign, the consumption of sauerkraut was greatly increased, and old hand methods of handling kraut, particularly when packing it into tins, proved inadequate to meet the demand. Because the fill of cans was not accurate, considerable



BECAUSE of the corrosive nature of kraut juice, it is essential that parts coming in contact with the liquor can be quickly and easily disassembled for cleaning. Corrosion-resistant materials are essential

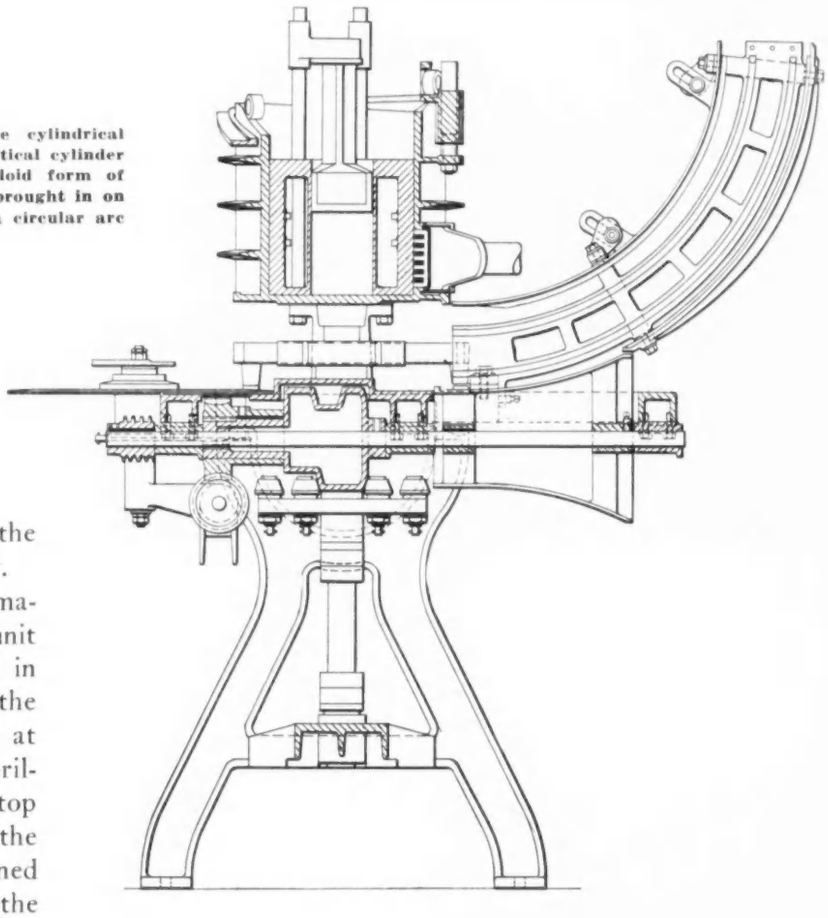
spoilage was caused from insufficient sterilization and overfilled cans, and an excess amount of labor was required. Furthermore, there was a great loss of juice which had to be replaced with salt brine.

The method of packing kraut then in use was to fork it from a bleaching tank into a hopper that fed one or two rotary filling tables, on which the cans were packed by hand. Loaded cans were carried by conveyor to an exhaust box where they were exhausted prior to being loaded into the closing machine. Leaving the closing machine, they passed through a can cooker where the necessary sterilization took place and then to a cooler before they were labeled and packed for shipment. When packed by this method, the temperature is limited to 100 deg. F., but since kraut is not sterile until it reaches a temperature of 153 deg. F., the latter cooking operation is necessary. Besides, the lactic acid present has a very corrosive effect.

It was about this time, 1922, that O. H. Hansen became interested in this branch of the canning industry through a chance meeting with Martin Meeter, a large kraut packer. It was through him that Mr. Hansen got an accurate picture of the problems involved, particularly by watching operations in one of the Meeter plants. For two years he studied the mechanical difficulties and how to overcome them. In examining existing equipment, cans were selected at random and opened, and each was found to be 1 to 2½ oz. overweight. Accurate filling then became the first essential of the new machine. Aside from the bad economy of overfilled cans, overfilling is thought by some authorities to be the cause of hydrogen swells. That it had been countenanced at all in the past was due to an effort to meet the Pure Food Law drained-weight requirements, at the same time maintaining fixed standards of acidity. During this extensive field investigation, the idea was conceived of packing the kraut above the sterilization point, at a temperature of 165 deg. F. or higher, to eliminate the later exhausting and cooking operations.

As far as the mechanical details were concerned, little could be gained by studying other types of canning equipment. Kraut cannot be measured by gravity as is done with peas, nor by a pump action as in the case of corn. It became necessary, therefore, to conduct painstaking and extensive experiments to find the simplest method of accomplishing the desired result. Another difficulty in designing a kraut filler was to find a means of cutting off the shredded cabbage without the cut showing in the can. All these problems were solved eventually, so that far from being the crudest method of filling cans, it is now as efficient as any used in the food packing industry. In perfecting these details, many kinds of metal were tested to find those that would withstand kraut acid, which is strong enough to eat through a ½-in. cast-iron bed plate within a year. Monel metal, Allegheny metal, chromium-plated bronze, and cast iron protected by acid-proof paint were the materials chosen.

After many minor experiments, the first machine was assembled and tested, and did prove



CROSS-SECTION of the cylindrical cam for indexing the vertical cylinder shaft; also the hyperboloid form of feed drum for the cans brought in on a chute in the form of a circular arc

that sauerkraut could be packed mechanically, and that the exhauster and can cooker could be entirely eliminated, thereby reducing the total plant investment in machinery by the substitution of the more expensive fully automatic unit.

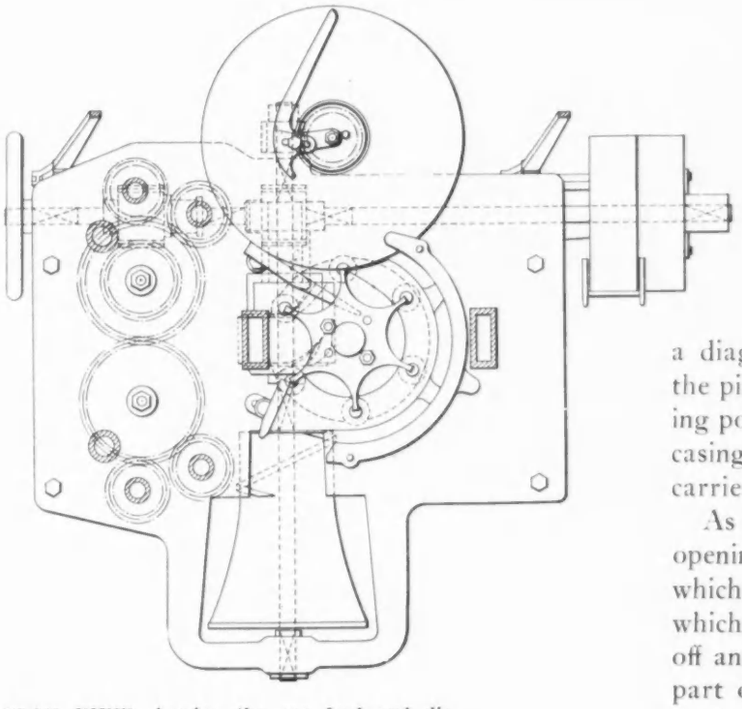
A number of other experimental machines were built before the first unit was announced at a demonstration in 1926. There the packers watched the machine handle kraut automatically at 170 deg. F., exhaust it, bleach it, sterilize it, measure it, brine it, pack and top it into sixty cans a minute and at the same time maintain the acidity. Drained contents of the cans picked from the filler every few minutes were found to be accurate in weight and in conformance with the Pure Food Laws. Further refinements have since taken place, so that the present model will can kraut quickly and accurately, eliminate spoilage because of overfilled cans, yet insure no underfilled cans, preserve the acidity and vitamins which are so essential to quality, and reduce labor costs 85 per cent.

Essentially the perfected machine consists of the filler proper, a feeding device for the kraut and one for the cans, and a can discharge table, together with the necessary driving mechanism. Intermittent rotation of the feed cylinder is obtained by a cylindrical cam and six roller followers carried on a disk rotating in a plane parallel to the axis of the camshaft and keyed to the vertical cylinder shaft. A Geneva movement was considered for this function but was dropped in favor of the present design. Drive is from a tight-and-loose pulley to two worms and wormwheels; one drives the camshaft, the other, the spur-gear train of the kraut-feeding mechanism. On the same shaft on which the cam is mounted is the cam feeder, shaped in the form of a hyperboloid with a spiral track wound on its surface at the lower end.

The filler consists of a central cylinder with six pockets in which pistons or rams reciprocate. Their function is to accept a charge of kraut from the hopper, forced in by feeding forks, compress it, rise to suck in a measured quantity of brine, and discharge the contents through a port exposed at the bottom of the casing into a can below. All this action takes place through a stationary end cam mounted on the outside casing and contacting roller followers on the pistons. Provision is made to adjust this cam in segments to vary the piston stroke at the point of feed and also at the point of brine injection.

As the unit was first constructed, Monel metal was used for the casing and for the pistons, which functioned in a bronze cylinder, but it was found that the hot lactic acid and brine acted as an electrolyte and resulted in the deposition of the bronze on the Monel. How to overcome this was a problem. Monel in contact with Monel did not appear practical. What was finally hit upon was the chromium plating and polishing of the entire bronze cylinder. Before the plate is applied, the block is heated and chilled to harden the wearing surfaces. Besides being corrosion resistant, the chromium is wear resistant, adding considerably to the life of the machine.

This cylinder block floats vertically upon the



PLAN VIEW showing the can feed and discharge; also the gear train for the feed fork mechanism. The feed forks are free to slide through cylindrical pivot members and are driven from a plate which is given a gyratory motion by two gear-driven cranks in parallel

drive shaft through which it is driven by a long flat key. Its own weight is borne on the bottom of the casing, lubrication being provided by the kraut juice. At first, attempts were made to lubricate the cylinder block at this point, and also the pistons, with a non-soluble grease applied by the conventional compression cup, but this was found to be an unnecessary precaution and was discarded. Grease lubrication of the drive shaft is used at its three bearing points. Where it runs in the cast-iron frame, bronze bushings guide it, but it bears directly on the Monel metal casing. The grease used is Nevastain, an odorless and tasteless, water-repellent Keystone grease.

As first designed, the Monel metal pistons were cylindrical in form with a flat face to which a guide member of the same material was bolted its full length. This guide engaged the lips at the edges of corresponding openings in the cylinders. Its purpose was to prevent the piston turning about its axis so as to maintain the roller follower on the end cam, as the cylinder block was revolved. At the highest position, because so much of the guide bar was out of the slot, the piston tended to skew from pressure on the cam roller and rapid wear took place at the cylinder lips. To overcome this, the cylinder was lightened by changing its section from a full length cylinder to the one shown and cutting the former flat guide from $9\frac{5}{8}$ in. to 2 in., at the same time providing two 1-in. bars to guide the top of the piston in all positions. These Allegheny metal guide rods are supported in the cylinder block at top and bottom and contact the pistons through a crosshead bolted to the top of the piston. This crosshead is made of a special analysis metal.

At the time these changes were made, a diagonal hole was cored in the lower end of the piston to permit the escape of air in the loading position. There is a conical depression in the casing at this point opening into a pipe that carries air and moisture back to the hopper.

As the cylinder block revolves, it uncovers an opening in the bottom of the casing through which the kraut is pushed, followed by the piston which extends into the can $\frac{1}{4}$ in. to pull in or cut off any loose ends of the discharge. During this part of the cycle and immediately before, when the kraut is compressed just prior to the introduction of the brine, the roller follower is constrained in its travel both above and below to make the piston action positive. In other positions the weight of the piston is sufficient. It might appear that a more positive method of driving the pistons would be necessary, but any advantage of a snappier action is offset by the feature of quick removal of the pistons and the cylinder. All surfaces coming into contact with the kraut are readily accessible, and can be cleaned easily.

Feed forks in the hopper propel the kraut toward the loading cylinder. Movement is such that when a pocket is presented to the hopper (piston in raised position) and dwells there instantly, the forks are pushing in the feed direction. While the cylinder is indexing between positions, the forks are withdrawing to the sides and swinging back. These forks work in pairs, and are linked at the outer ends to a plate which is given a gyratory motion by two gear-driven cranks operating in parallel. Each fork is free to slide through cylindrical sleeves whose fixed axis of rotation is perpendicular to the fork. With cylindrical sleeves, a satisfactory seal is obtained at the hopper sides no matter what position the forks may be in. The orbits described by the fork points are such that the motion is much more rapid during the feed cycle than during the withdrawal and return.

Varying the position of the pivot points and the length of the forks varies the orbits described. For the forks nearest the cylinder, complete withdrawal from the hopper is necessary to prevent

pushing kraut away from the feed on the return stroke. Before swinging back, this fork shoots out radially and gets in position to exert pressure on the kraut toward the cylinder. Allegheny metal was the material chosen for the forks, which run through chromium-plated bronze guide cylinders. The hopper is cast of Monel metal. For the spur driving gears a special aluminum bronze containing vanadium is used.

The plan view shows the arrangement of the drive to the cranks. Power is introduced to the main drive shaft through a worm and wheel, the worm-wheel being made of this special bronze and the worm itself of Allegheny metal.

Being well protected from splashed kraut juice by the cast-iron bed plate, which itself is shielded from direct contact by the Monel-metal casing, the cylindrical cam and its roller followers need not be of stainless materials. A hollow cast-iron cam has been found satisfactory and has the advantage of being readily machinable. The conical follower rollers are case-hardened steel, and are carried on a cast-iron disk keyed to the vertical cylinder shaft. Provision is made for vertical adjustment of the plate by a nut and locknut on the shaft to take care of the wear on the cam and followers. A similar arrangement provides adjustment of the bronze thrust washer on the lower end of the shaft.

Cans are usually fed to a machine of this type by an overhead mechanical conveyor and approach the machine by gravity in a vertical direction. One of the illustrations shows a 90-deg. radius arm that brings the line of cans horizontally into the machine. From this view it is also evident why the feed roll is shaped as a hyperboloid, since its cross-section is tangent to the sweep of the curve at one point and to the table at the other.

At the narrow end of this hyperboloid a spiral worm has been riveted to the surface and is so designed as to place the can ahead of the can hook or spider and inside of the can guard, making it impossible for the can to get smashed between the can hook and the corner of the can chute, which frequently happens when the cans are fed straight into the can hook. This hook is made of aluminum and is bolted to a collar that is setscrewed to the shaft. On the discharge side the cans are deflected onto a revolving disk consisting simply of a $\frac{3}{8}$-in. plate of Allegheny metal bolted to a cast-iron hub, driven by a worm and wheel from the camshaft. An adjustable guide directs the exit of the cans and prevents any from being carried back into the machine.

What Is the Reason?

By Paul B. Swinton

WE were having a lively discussion as to the extent to which the engineering department should specify the shop processes to be used in the manufacture of the design. Bill Reeves, Superintendent of the Machine Shop of Valley Steel, was very emphatic in presenting one side of the question and insisted that it was none of the engineering department's business what manufacturing process was adopted so long as the final result conformed to the blueprint and specifications. Bill certainly seemed to have the best of the argument, his premise being that as the shop was responsible for manufacturing costs, and as these costs were dependent upon the process used, the engineering department should have no authority to specify such items. Everybody seemed to be in 100 per cent agreement with Bill until Mason, general superintendent of the Gear Specialties Company, spoke up.

"Quite some years ago, we were in the habit of pouring our babbitt bearings in the usual manner. This was satisfactory until the bearing loads became much higher, and then we began to have trouble. I admit that the idea started in the shop, but the fact is we changed our method and cast the bearings centrifugally.

"In another instance, we decided to broach the babbitt bearings in order to make sure that the bore would be exact for all bearings. Thus, with the broach of the right diameter, we would be assured that the bore of the bearings would be correct. Our shop tests of machines having these broached bearings showed them to work splendidly. However, within a week after we had put the machines into actual service, we started to receive complaints from the customers that the babbitt bearings seized on the shaft. For a long time, we could not explain this situation, but finally we discovered that when the babbitted bearings became heated after having been broached, the babbitt swelled, thus giving a smaller diameter to the bore of the bearings. The bearing temperatures in service were sufficient to cause the babbitt to swell enough to seize the shaft. This situation was, of course, remedied at once by boring out the bearings on a lathe.

"Now, the question that I want to ask is this: In the two instances that I have described, would not the engineering department be perfectly justified in specifying centrifugally cast bearings and specifying them to be bored, not broached?"

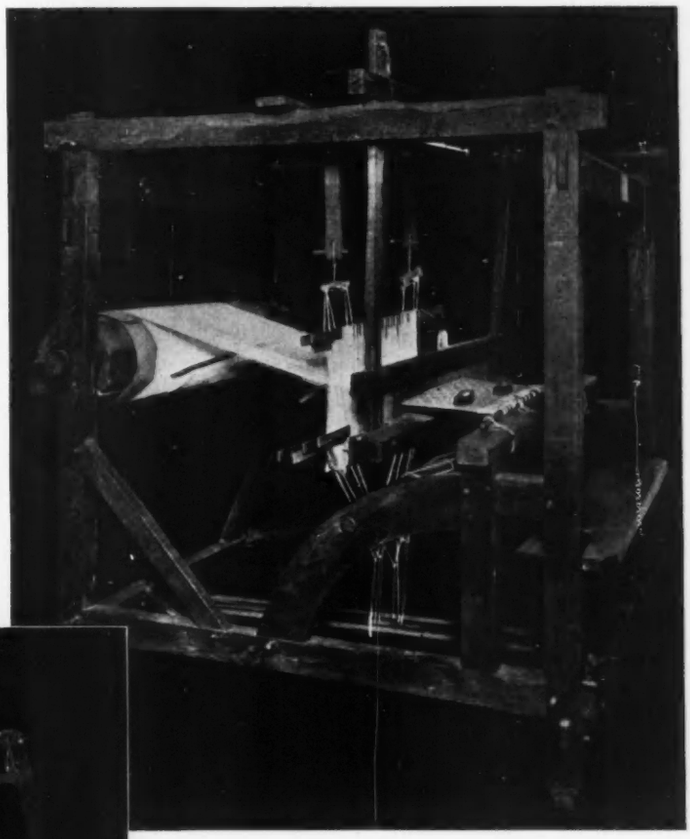
Progress in Design of Cotton Looms

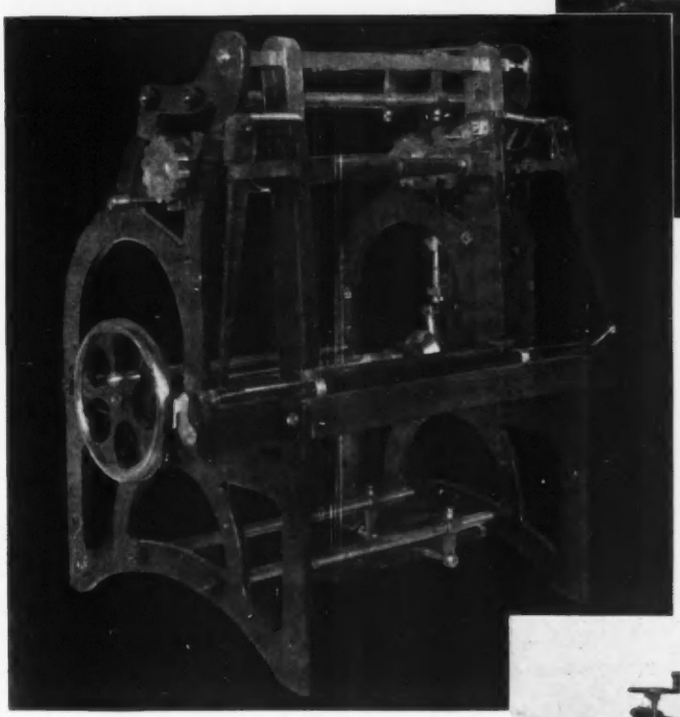
Photographs from Albert Palmer
Research Assistant to the President
Crompton and Knowles Loom Works

THE history of the loom from its infancy, when it was simply two vertical posts with the warp stretched between, to this hand loom of 1813 is a story of slow development over a period of many centuries. The invention of the flying shuttle by John Kay in 1730 paved the way for the substitution of mechanical movements for hand operations.

Application of power for driving the loom was the next step, but before this could be accomplished many mechanical refinements had to be made. It was not until 1785 that Cartwright's power loom was invented. Below is shown the Cartwright loom, introduced to the United States in 1837 by William Crompton.

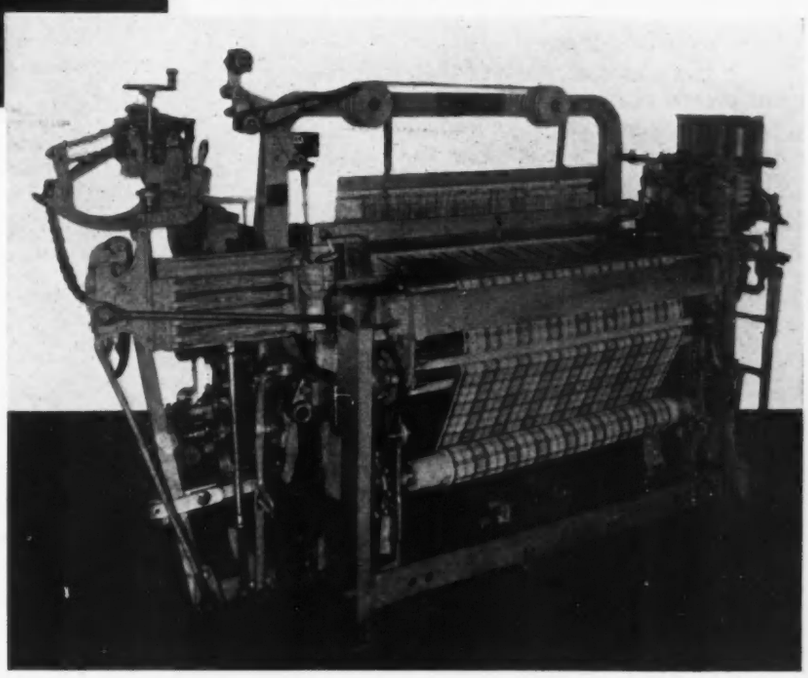
During the years that followed, various parts and mechanisms were developed and improved,





both in design and manufacturing accuracy. Where lightness was required, pressed steel replaced castings. Anti-friction bearings, heat-treated steels, accurately cut gears, and steel springs contributed to the modern design of cotton loom shown below. Thus the accumulated efforts of many designers finally multiplied production of the weaver a thousandfold.

Other historical product picture pages were published as follows: 100 Years of Locomotive Design, Jan. 1930; 80 Years of Sewing Machines, Feb. 1930; 100 Years of Harvesting Machinery, Mar. 1930.



COMMENT AND SUGGESTION

THE COMMENT AND SUGGESTION SECTION is a forum for exchange of opinion. Readers are invited to write letters discussing matters of current interest to development engineers. Articles of a controversial nature, however, will be published only with a bona fide signature.

▼

Mechanical Smelling

By John Hyler

A PARAGRAPH in the May issue of *Product Engineering* raises the question as to whether mechanical smelling will be developed, and how. It is my understanding that this has already been developed. The "nose" in question is an electrical one, and is fitted with a tube which can be inserted into any suspected area. Vapors are sucked in through the tube and into an airtight cavity, where they are passed over heated wires of platinum. Different gases passing over these wires change their resistance to the current flowing through them, and these changes are registered by a needle on a dial. It would seem to be but another step to a mechanical response, for if a needle can be operated on a dial, it should also be possible to operate a relay, even though it were necessary to use the electric eye in connection. One can almost visualize an elevator refusing to drop into an area where there are dangerous gases, or some keen-scented excavator following the gas mains, and automatically setting to work when the leak is reached. No doubt these things will come.

■

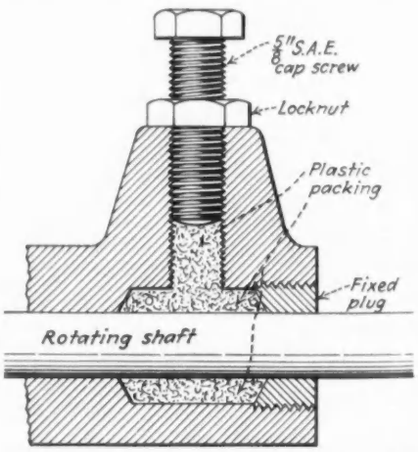
Getting Rid of Glands

By Herbert Chase

ALTHOUGH glands are by far the most common means of packing shafts of pumps, they are known to be the cause of many minor troubles, and for lack of proper adjustment or packing they often give rise to leaking which is serious in some cases. Another trouble is that glands often are inaccessible and frequently require for tightening them a special spanner or wrench.

A simple means of overcoming these disadvantages is to employ the construction shown in the accompanying sketch. It involves the use of a cored or recessed opening surrounding the shaft at the point where the gland normally would be placed. To facilitate machining, an annular plug threaded into the hole that forms the recess may be employed, but this is not essential. If used, the plug is screwed home after the recess is cut out and threaded, but thereafter need never be disturbed. The ends of the recess should be beveled. When the plug is seated it can be drilled and reamed at the same time that the same operations are performed on the body casting, thereby assuring perfect alignment of the hole in the plug and that in the main casting. Clearances allowed are the same as if a gland were employed.

Entering the recess at right angles to the shaft is a fairly deep hole threaded to receive the body of a fine-threaded bolt, say $\frac{5}{8}$ in. S.A.E., fitted with a lock nut and of such length that it cannot be screwed down so far as to touch the shaft. When ready for use with the shaft in place, the cavity around the latter and most of the hole is filled with plastic packing or with granular babbitt packing, impregnated with graphite. The screw is then inserted and screwed down enough to force the packing firmly against the shaft.



Substitute for an ordinary gland. The plastic packing is put under pressure by turning the fine-thread screw. The screw plug around the shaft is employed only to facilitate machining

Since very heavy hydrostatic pressures can be developed by turning

■

STOP... LOOK... LISTEN...

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. . . NEW TRANSMISSIONS . . .

NEW designs are under way in automobile transmissions. Silent seconds, synchro-mesh, and free wheeling have spurred designers into other fields, and a new kind of friction transmission has been under test for many moons. It can be set to work automatically under control of the road resistance, or at the will of the man behind the wheel. Then too, there is a device that releases the clutch automatically when you take the foot from the accelerator and gives free wheeling. This is no time for designers to go to sleep and wait for better times.

•

. . . HIGH SPEED . . .

THE award of the prize of the French Astronomical Society to Professor Pierre Montague for the mathematical solution of a measurement of combustible fluids to be used to propel a rocket into space, recalls that the American Captain F. M. Williams made the prophecy that within ten years rockets would be making the trip between Germany and the United States in three hours. Mr. T. R. MacMechen, the genius who built the first British Zeppelins, invented several propellers, and has patents on rockets, visits the office of *Product Engineering* occasionally. He predicts: that rockets driven by liquid hydrogen will carry mail and passengers to France in one hour and be landed within a 2-mile field. If there were a war, such rockets would be built immediately, but it may take a generation to develop them otherwise for commercial use.

•

. . . IDEAS WANTED . . .

A SIGNIFICANT trend might be traced in the appointment of Bobby Jones, sportsman winner of the four major golfing titles of 1930, as a product development man for A. G. Spald-

the screw, the cavity is filled completely. The wall thickness of the body casting must be sufficient, of course, to withstand this pressure without rupture, but the pressure should not be made so great as to prevent she shaft from turning with reasonable freedom. Only enough pressure need be exerted to assure a tight joint. If any leakage occurs after a period of use, it can be stopped instantly by tightening the screw, which requires no special tools.

This substitute for a gland has been used with considerable success on gear pumps employed in the automotive engine steam cooling system developed by S. W. Rushmore, who supplied the foregoing particulars. I understand that it has been employed also for steam turbines. When the granular babbitt and graphite mixture is employed, it not only serves as a packing, but makes a good bearing that requires no lubrication whatsoever.

■

Welcome to the U. S.

By J. A. Covington

THE Applied Mechanics Division of the A.S.M.E. has been dubbed, in a humorous spirit, as the "highbrow" division of the A.S.M.E. Besides being highbrow, this division has another distinction.

At the dinner conference during the First National Meeting of this division at Purdue University, the following members took a prominent and active part. As a matter of interest, we quote in brackets the land of their birth:

Presiding at the dinner was Dean Potter (Russia), who introduced the principal speakers, Messrs. Timoshenko (Russia), Soderberg (Sweden), Lessells (Scotland), Bakhmeteff (Russia), the only American-born speaker on the program being an invited guest, Dr. Boardman, president of the University of Maine, and president of the Society for the Promotion of Engineering Education.

Other prominent members of the A.S.M.E., who delivered papers at the Applied Mechanics Division meeting were Dr. Nadai (Hungary), Karelitz (Russia), Dr. Tietjens (Germany), Van den Broek (Holland), den Hartog (Holland), and Dr. Frocht (Russia).

ing & Bros., to work on golf implements at the research laboratory of the company. What apparently are needed as much as stresses, strains, and calculations in new developments are ideas of what users want.

●

. . . LIGHT REFLECTION . . .

WE have heard much about the off-color of chromium that makes it unavailable for certain decorative uses. Now comes another side—Carleton Ryder, in an article in "Good Furniture and Decoration," says that the average reflection value of chromium plate is superior to silvered glass. That is a quality that the designer should remember, as brilliancy and reflection are often called for on parts of metal products.

●

. . . MATERIALS AND PRODUCTION . . .

THE engineer who doesn't consult the production man before he gets very far with a new design misses many a bet. Both machine equipment and capacity affect seriously the cost of production, and the engineer's salary like that of all the rest, depends on how much a product can be sold at a profit. One designer specifies material that cannot be machined with present equipment and loses out. Another consults production and finds it can be cut in his shop, and wins. Then, too, the man consulted is a lot more anxious to help out than the one who gets a blueprint stuck in his face without previous consultation.

●

. . . "WHEN TIME ALLOWS" . . .

ONE of the New York Sunday papers has gone in for 32 solid pages of comics because it claims that the studies of journalistic schools indicate that "bankers, university presidents, professors, doctors, and lawyers read comics as avidly as front page news." Its publicity does not mention engineers. Perhaps engineers are more serious than university presidents. Nevertheless, there is a lot of human interest attached to product development, and engineers might do well in exchanging some of these—not comic, but interesting—examples. The ancient Greek was wise who said, "When time allows 'tis wise to play the fool."

●

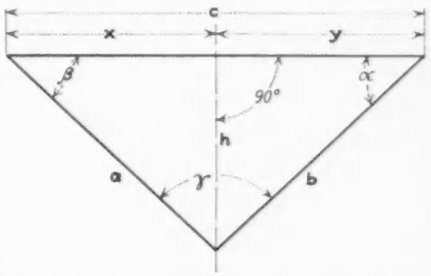
. . . 245 M.P.H. STEELS . . .

TIME was when the designer just specified "steel," or if he was very fussy he would say "high carbon" or "tool steels." But the designer of today has a wide choice of materials and must know their characteristics and properties. Capt. Campbell's Blue Bird that made 245 m.p.h. at Daytona used six different kinds of steel in some of which nickel, chromium and molybdenum played their part. All, however, had from 2.75 to 5.50 per cent of nickel. These gave maximum strengths of 110,000 to 190,000 lbs., the lesser strength being for normalized steels used in the frames, the highest for rear axle shafts, propeller and transmission shafts, and differential.

Calculation of Triangle

By C. H. Grill

IN the May number of *Product Engineering* on page 225 there appeared an article "Simplified Triangle Solution." This solution may be simple, but it does not eliminate the labor of solving for the cosine of each of the three angles of a triangle.



Finally, the long procedure leads to inaccurate results.

The following equation has been used by me for some time with gratifying results as to accuracy as well as a considerable saving in time. Referring to the accompanying figure:

$$x = \frac{a^2 - b^2 + c^2}{2c}$$

and

$$y = \frac{b^2 - a^2 + c^2}{2c}$$

Angles α and β can now be found from

$$\text{cosine } \beta \frac{x}{a}$$

$$\text{cosine } \alpha = \frac{y}{b}$$

and $$\gamma = 180 - (\alpha + \beta)$$

The squares appearing in the above formulas should offer no obstacle to anyone having the use of a table of squares, it being merely a matter of looking up the proper squares, adding, subtracting, and finally dividing by $2c$. It is also evident that as $x + y$ must equal c, the use of this formula gives an immediate check before the values of the angles are calculated.

■

The Bicycle Paradox

By John P. Ferris

Chief Engineer, The Oilgear Company

IN the article by John Alden on page 224 of *Product Engineering*, proof is rested on the fact that, if transferred to the rear wheel, the force applied to the pedal would create a moment to the right around the instantaneous center of rotation. Mr. Alden makes the reservation that

this proof holds "except for the effect of the sprocket ratio."

It is interesting to note that this reservation contains the heart of the matter. No force is actually applied to the rear wheel at P'; there are two forces, one at the center of the rear wheel applied by the bearing, and another on the upper teeth of the sprocket applied by the chain. The force at the center tends to rotate the wheel to the right, and the chain pull tends to rotate it to the left. It will rotate in one direction or the other according to which of the moments created by these two forces is the greater. With the ratios of an ordinary bicycle, the moment to the right is greater and the bicycle will move to the right. But if the ratios are modified slightly, the bicycle will move to the left, *against* the force applied.

■

Part Number Consciousness

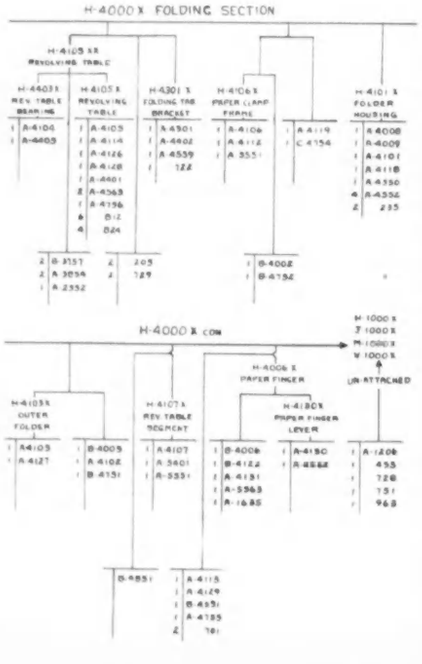
By Clifford P. Wicks
Chief Product Draftsman, Yale & Towne Manufacturing Company

PART numbers are often meaningless combinations of figures, but admittedly necessary to coordinate production and records. Arbitrary numbers serve as well as any others for strictly clerical departments, but for engineering, production, inspection, and stockroom work these meaningless numbers are an expensive evil because of the time lost in looking them up, and the need for carrying both the number and the name of every record. Where a small number of products are manufactured, it is a simple matter to give the part numbers life, character, and meaning.

Only two steps are required to make every employee part number conscious. First, the use of short numbers; second, the placing of part numbers before all interested employees in a convenient and understandable arrangement of part lists and assembly charts.

A plan for establishing suitable short part numbers which is easily adapted to many types of product is briefly outlined. The first of the four figures used indicates either the product or the major section of the device in which the part is used. The second figure determines the character of the part, such as screw-machine, wrought sheet metal castings, or springs, each class being sub-divided where desirable. The last two figures are used in numerical sequence, and are the only ones which really need to be learned. Prefix letters may be used to denote design changes, and suffix letters to indicate assemblies.

The illustration shows two pages of a typical part list and assembly chart reproduced on white ground prints. Books of these prints with corresponding part lists and charts on facing pages provide a practical method for distribution of the data.


H-4000 X FOLDING SECTION
H-4105 XX REVOLVING TABLE
H-4403 X REV. TABLE BEARING
H-4105 X REVOLVING TABLE
H-4301 X FOLDING TAB BRACKET
H-4106 X PAPER CLAMP FRAME
H-4101 X FOLDER HOUSING
H-4000 X CON
H-4003 X OUTER FOLDER
H-4107 X REV. TABLE SEGMENT
H-4006 X PAPER FINGER
H-4130 X PAPER FINGER LEVER
UN-ATTACHED

NO.	NAME	QTY.	FOR	WITH
H-4000 X	FOLDING SECTION			
H-4002	Paper Clamp Shaft	1	H-4000 X	H-4106 X
H-4003	Folder Shaft	1	H-4000 X	H-4103 X
H-4006	Paper Finger	1	H-4006 X	
A-4008	Upper Folding Roller	1	H-4101 X	
A-4009	Lower Folding Roller	1	H-4101 X	
A-4101	Folder Housing	1	H-4101 X	
A-4102	Inner Folder	1	H-4000 X	H-4103 X
A-4103	Outer Folder	1	H-4103 X	
A-4104	Folding Table Frame	1	H-4403 X	
A-4105	Revolving Table	1	H-4105 X	
A-4106	Paper Clamp Frame	1	H-4106 X	
A-4107	Revolving Table Segment	1	H-4107 X	
A-4112	Paper Clamp	1	H-4106 X	
A-4113	Paper Finger Retainer	1	H-4000 X	H-4006 X
A-4114	Paper Rest	1	H-4105 X	
A-4118	Paper Clamp Actuator	1	H-4101 X	
A-4119	Paper Clamp Lock	1	H-4000 X	H-4106 X
B-4122	Paper Finger Link	1	H-4006 X	
A-4126	Revolving Table Brace	1	H-4105 X	
A-4127	Lower Folder Finger	1	H-4103 X	
A-4128	Revolving Table Extension	1	H-4105 X	
A-4129	Paper Finger Stop	1	H-4000 X	H-4006 X
A-4130	Paper Finger Lever	1	H-4130 X	
A-4131	Paper Finger Washer	1	H-4006 X	
A-4301	Folding Table Bracket	1	H-4301 X	
A-4401	Revolving Table Hub	1	H-4105 X	
A-4402	Folder Pinion Bearing	1	H-4301 X	
A-4403	Revolving Table Bearing	1	H-4403 X	
A-4550	Folder Actuator Rack	1	H-4101 X	
B-4551	Revolving Table Segment Screw	1	H-4000 X	H-4107 X
		1	H-4000 X	H-4006 X
A-4552	Folding Roller Pin	4	H-4101 X	
A-4559	Folder Pinion	1	H-4301 X	
A-4562	Paper Finger Spring Stud	1	H-4130 X	
A-4563	Ball Container	2	H-4105 X	
	V-5107 X	1		
B-4751	Folder Return Spring	1	H-4000 X	H-4103 X
B-4752	Paper Clamp Spring	1	H-4000 X	H-4106 X
B-4754	Paper Clamp Lock Spring	1	H-4000 X	H-4106 X
A-4755	Paper Finger Return Spring	1	H-4000 X	H-4006 X
A-4756	Finger Holding Spring	1	H-4105 X	
	V-5107 X	1		
	Parts from other Sections			
A-1635	Chute Plunger Stud	1	H-4006 X	
A-2552	Nut Pin	1	H-4105 XX	
B-3757	Detent Spring	2	H-4105 XX	
A-3854	Detent Ball	2	H-4105 XX	
A-5401	Breaker Blade Actuator Roll	1	H-4107 X	
A-5551	Paper Jaw Actuator Stud	1	H-4106 X	
		1	H-4107 X	
A-5563	Paper Gripper Stud	1	H-4006 X	

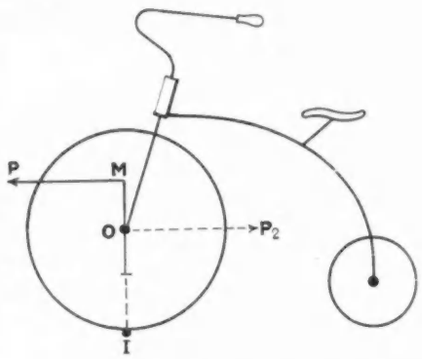
Sample pages of a typical part list prepared by the engineering department for general factory use

The Bicycle Paradox

By L. S. Michael
Engineer, Blaw-Knox Company

AS interesting, and almost as puzzling, a question as that of John L. Alden (*Product Engineering* for May, page 224) is, "Why will the bicycle move forward when the rider presses forward against the upper pedal?" Is not the horizontal reaction P_2 against the frame (axle) equal to the horizontal component P_1 against the pedal? This being true, why does the vehicle move?

The solution lies in the fact that I is still the instantaneous center, and



Horizontal reaction P_2 equals the forward push P on the pedal. Why does the vehicle move?

that the accelerating moment $P_1(IM)$ is greater than the retarding moment $P^2{}_{\mathrm{A}}I0)$. This unbalanced condition tends to accelerate the bicycle or to overcome resistance to motion. If the force P of Mr. Alden's problem were applied by the rider, the horizontal reaction would be equal and opposite and against the frame. "I" being the instantaneous center, the lengths of the lever arms, or radii, of "force" and "reaction" now differ, creating an unbalanced condition similar to the one previously described. In this case, however, it is the reaction that propels the bicycle, since its lever arm is the greater.

■

Stresses in Rings—Formula

IN Equation 9a in the article "Stresses in Rings of Symmetrical Cross-Sections" an page 208 of the May number an error has been pointed out. The equation should read:

$$m = 2\left(\frac{R}{r}\right)^2\left[1 - \sqrt{1 - \left(\frac{r}{R}\right)^2}\right]$$

Graphic Determination of Surfaces, Volumes and Weights

IN answer to a request from Canadian Export Managers Limited, a simple chart for the rapid determination of areas, volumes, and weights is here presented. This chart can be constructed easily without the necessity of making any calculations. As shown in the accompanying figure, a square *ABCD* is first drawn, having a length of 10 in. on a side. This is the same length as the standard slide rule. The right side of the square extends 10 in. above and below.

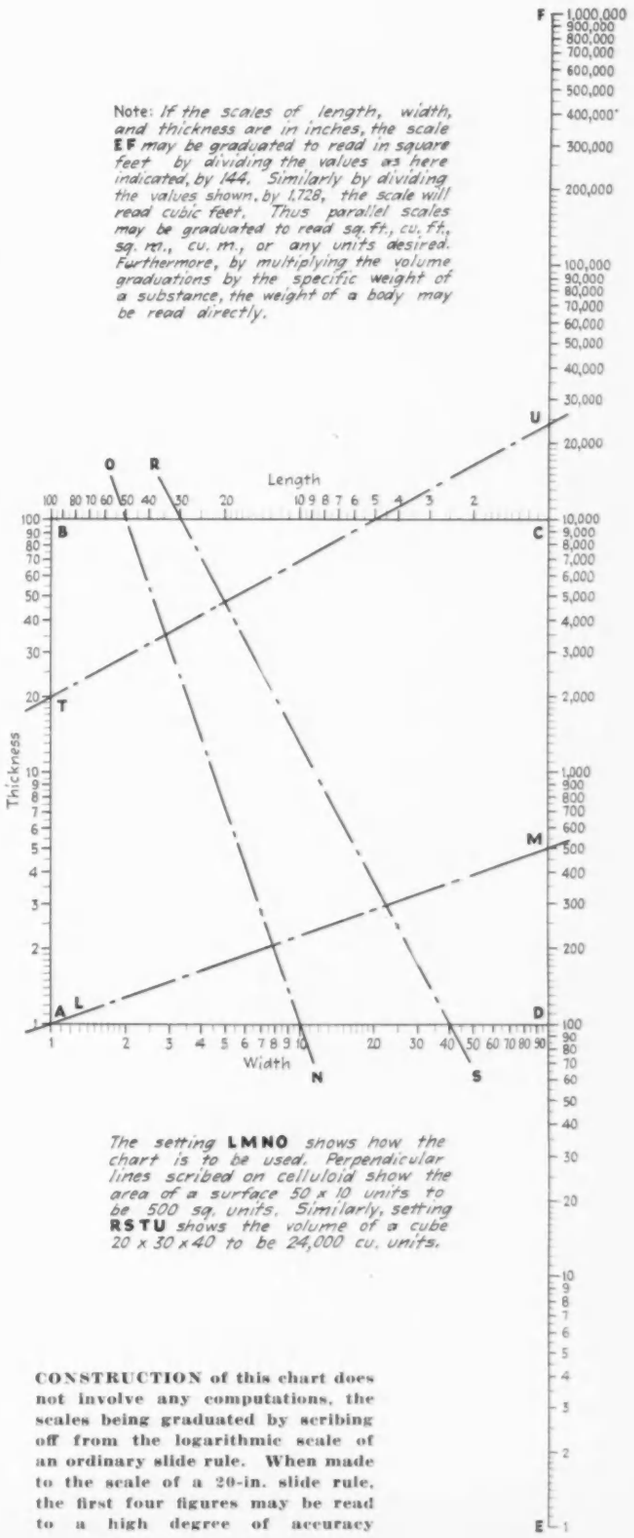
In order to locate the graduations on the various scales, use the slider of a slide rule. Thus the scale *CB* is obtained by placing the "C" logarithmic scale of the slider so that the digit *1* coincides with point *C* and the digit on the slider representing *100* coincides with point *B*. It is then merely necessary to scribe off the different graduations. Similarly, the scales *AB* and *AD* may be constructed. The scale *EF*, which should be made 30 in. long, is obtained by laying off the logarithmic scale successively from *E* to *D* and again from *D* to *C*, and for the third time from *C* to *F*. The point *D* will then represent 100; the point *C*, 10,000; and the point *F*, 1,000,000.

To use the chart, scribe two perpendicular lines upon a piece of celluloid or other transparent material and place on the chart as shown in the illustration. If area is desired, the one line of the perpendiculars is passed through the points representing the dimensions, while the other perpendicular line passes through unity on the "thickness" scale. Where this line intersects the right-hand vertical scale will be found the answer. The illustration shows the setting for obtaining the area of a surface 10x50, and also the setting for obtaining the volume of a rectangular parallelopiped or box 20x30x40. The units used are immaterial.

The unit in the *EF* scale will be the same as the unit in the other three scales. However, conversion scales from cubic inches to cubic feet, or square inches into square feet, may be tabulated as indicated in the figure. It will then be possible to read square feet in area or cubic feet in volume when the dimensions are given in inches or other units.

Although the chart as illustrated is limited to linear dimensions up to 100 in., actually there is no limit to the possibilities, since by merely spacing off decimal points this chart can be used for quantities greater than 100. The procedure followed would be exactly the same as in reading the slide rule.

The chart here presented has been constructed accurately but is not large enough for exact determinations. For this reason a chart measuring 10 in. on a side is recommended. If a still greater range and degree of accuracy is desired the chart would be made correspondingly larger. Such a chart, 60 in. long and 20 in. wide could be set up as a permanent fixture on a drafting board for making rapid determinations of areas, volumes, or weights, and would give exact results to three figures with a close estimate of the fourth figure.


Note: If the scales of length, width, and thickness are in inches, the scale EF may be graduated to read in square feet by dividing the values as here indicated, by 144. Similarly by dividing the values shown, by 1,728, the scale will read cubic feet. Thus parallel scales may be graduated to read sq. ft., cu. ft., sq. m., cu. m., or any units desired. Furthermore, by multiplying the volume graduations by the specific weight of a substance, the weight of a body may be read directly.
Length
Thickness
Width
The setting LMNO shows how the chart is to be used. Perpendicular lines scribed on celluloid show the area of a surface 50 x 10 units to be 500 sq. units. Similarly, setting RSTU shows the volume of a cube 20 x 30 x 40 to be 24,000 cu. units.

CONSTRUCTION of this chart does not involve any computations, the scales being graduated by scribing off from the logarithmic scale of an ordinary slide rule. When made to the scale of a 20-in. slide rule, the first four figures may be read to a high degree of accuracy

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

August, 1931

. . . "The time will come when no engineer will be considered fitted for his profession who has not imbibed some of the principles of art and proportion" . . .

—ERNEST ELMO CALKINS.

Ultimate Responsibility

HOW far is the designer responsible for poor results caused by errors, omissions, or improper methods in producing the product in the shop? Theoretically, he has no responsibility at all for factory production, but he cannot escape the conviction that he has a grave responsibility that the machine he designs is produced properly within certain limits of cost.

There is nothing more disheartening to a conscientious designer than to go into the shop and see rough-appearing castings that could have been fine and smooth if care had been used in the foundry sand, or to see time and money wasted machining bronze with hard spots that could have been avoided if the parts had been bought from specialists who had the proper technique. On the other hand, it is a source of pride if he can see the parts of his design going harmoniously through automatic machining operations.

In the design of the Navy airship Akron it was notable that a very large proportion of design attention was given to means and rigging for building the ship economically. These were planned at the same time that the ship designs were developed. It is only one example to show that the product development engineer must keep in mind how his product is to be built, and by advance cooperation with the manufacturing executives eliminate the "headaches" that so often occur when the new design reaches the shop.

Skidding Close

ENGINEERS, according to popular notions, are extremely conservative. It is generally supposed that in the design of machinery all parts are made with a generous factor of safety in order to assure against failure either by breaking or lack of rigidity.

Actually, engineers engaged in the design of competitive products cannot produce commercial successes unless they skid close to the borderline of failure. Everything must be designed to have just the required strength and durability, but no more. That material must be selected which will meet the requirements at the lowest cost. The finish specified must be compatible with the conditions to which it will be subjected. The parts selected must be of the most economical type capable of doing the work.

Evidently, stresses must be calculated to a nicety. Service conditions must be studied and analyzed, and the results of experiments and research must be given consideration. Behavior of different materials and their characteristics as to strength, elasticity, wear, corrosion-resistance, and other factors must be studied. Comparative merit of standard parts for performing the same function but employing different engineering principles must be established. Lubrication requirements, sealing parts against the entry of dirt, safety provisions, finishing materials, and many other factors must be considered, all to the end that a readily salable product may be produced at the minimum cost. It sounds paradoxical, but the fact is the closer his designs come to failure, the more valuable becomes the engineer. But he must never overstep the intangible line marking the boundary of a successful design.

■

Revise the College Courses

FEAR is being expressed in some quarters that, as is the situation this year, there will be a tremendous surplus of engineering graduates during coming years, with the result that the economic status of the engineer will be lowered. Suggestions are being made that the colleges should restrict enrollment, that they should forecast the needs of industry and set up an "inven-

tory control." Such a course under any circumstances would be impractical, probably impossible to carry out, and would be unjust to the men who may be barred arbitrarily from college. Furthermore, as revealed in a survey conducted by the American Management Association, in every "normal" year there has been a decided shortage of engineering graduates.

The real problem to be solved is how to select the young graduate for filling a given position. There is nothing to distinguish the student who has taken his courses seriously and aspires to further technical knowledge, from him who "got by" at the behest of doting parents or in spite of excessive time devoted to "outside" activities. Classroom and examination marks do not tell the whole story. Records of men attending different institutions cannot be compared because the quality standards of the colleges vary widely. The mediocre man of one institution may be superior to the outstanding man in another. Personnel managers have an impossible task in attempting to make a perfect selection.

Their task would be simplified if those responsible for engineering teaching would give more thought to the standardizing of high quality in teaching instead of the standardizing of the catalog content of courses of study. The personnel manager, if he is wise in his selection of men, will be more interested in who taught the embryo engineer, and how he was taught, than in the specifications of what was supposed to have been included in his class work.

Much might be accomplished if the colleges could tear away from the traditional four-year course which has been a fixture in spite of the ever increasing field of knowledge to be covered. A three-year course with a B.S. degree in engineering would satisfy the social demands for college education. The course would stress the fundamental sciences, business administration, and the humanities. Graduates from such a course would fill the requirements of industry for men having a general technical training.

For those men who really aspire to a professional standing, the colleges could offer an additional two-year course specializing in certain branches leading to an engineering degree. Being more matured, the student would make a more intelligent selection of the branch of engineering he wished to follow. The quality of work would be far superior to that done in the present undergraduate courses, and the final product would have a greater immediate economic value to industry.

■

We Need No Oracle

TWO recent developments part the veil for the engineer to peer into the future and get an idea of the products most likely to be the new leaders in the next upward trend of business. The round-the-world-flight in less than nine days, followed closely by two other successful transatlantic flights, is convincing the public of the safety and mechanical excellence of the present-day airplane. It has given the feeling that design is progressing rapidly, and this is reflected in more flying by the public as well as in greater tonnage of air express and mail. Air express shipments in the first five months of 1931 were more than three times those of the same period of 1930. An air freight service starts on August 1. Airplane manufacture will boom at the first show of general improvement.

Another indication is seen in the momentum recently given to research and development by the opening of regular television broadcasting services. Regular television programs are being put on the air, and the Columbia system has just established eight "looking-in" posts at strategic points to observe and study the effects of the experimental broadcasting. Simultaneously comes the announcement of television sets retailing below the hundred dollar mark, and also "amateur kits" for field experimentation and practical use. Television has been "just around the corner" for a long time. It should now be in a position to turn the corner.

These are examples where activity indicates a trend. There are other cases, also, where logical reasoning will indicate trends. What of the possibilities for air-conditioning apparatus to be installed in every modern home? What of the possibilities for complete revamping of railroad equipment to take advantage of experience gained with light-weight construction materials in the airplane industry? And so on—Now is a good time to look our own products squarely in the face and try to forecast what they will have to be like to meet future sales needs.

WHAT'S GOING ON—

Engineering Notes

Design difficulties with the new United States Navy cruisers have worried designers during the past few weeks. Defective stern posts were discovered in five of them, all of which, according to reports, cracked while the cruisers were making full speed runs at 32 knots. A board of naval constructors has been commissioned to determine whether the defects were the result of poor castings or improper design. It is significant that the defects in the five cruisers were identical. To further complicate matters, the trials of the guns on the cruisers brought out the fact that the vessels, because of an extremely low center of gravity, pitched and rolled in heavy seas to such an extent as to impair the accuracy of the gunfire. This means that ballast tanks, fins, rudders and similar appurtenances must be added at the same time the defective stern posts are changed. Evidently it is still true that defective design costs money.

Akron today holds the center of the stage in the development of airships, and August will witness events that will largely determine the future of the development of lighter-than-aircraft in the United States. It is expected that during the second week of August Mrs. Hoover will christen the world's largest airship, the product of the Goodyear-Zeppelin Corporation, that the trial flights will be completed in August, and that the ship will then proceed to Lakehurst.

According to the specifications, the craft is 785 ft. long and has a capacity for 6,500,000 cu.ft. of helium gas. The gross lift of the ship will be 403,000 lb., giving it a useful load of 182,000 lb. The useful load may be reduced by as much as 20,000 lb. on account of the dead weight exceeding the estimated amount.

The Goodyear-Zeppelin Corporation, which is constructing the airship, estimated that the weight would be 221,000 lb., but it is now reported that the airship will weigh approximately 240,000 lb. of which changes in design initiated by the Navy Department account for 5,000. Naval officials, however, contend that the exact amount of overweight cannot be determined accurately until the airship is completed and "weighed" off. The Navy Department takes the position that the increased weight will aid materially in increasing the safety and military factors of the airshp.

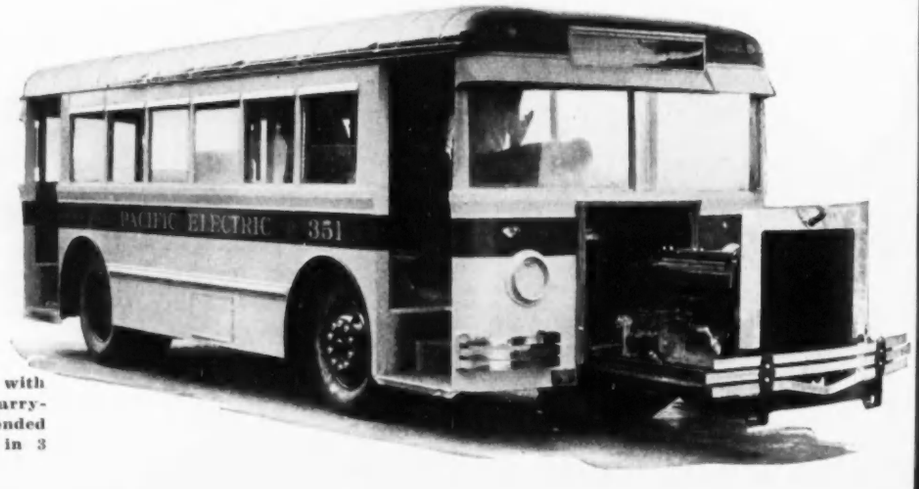
The cruising speed of the airship will be 50 miles an hour and her cruising radius is expected to be about 9,000 miles.

After the Akron has been subjected to thorough tests, it is intended to begin the construction of a second ship of the same design and dimensions which has been authorized by Congress. Naturally, great interest will be centered in the trial flights.

The Columbia Broadcasting Company is first to broadcast with both images and sound, putting on regular television programs daily. It is, of course, obvious that the reception will be crude compared to what may be expected in the future, but it will undoubtedly compare favorably with radio reception ten years ago. It will be interesting to watch the development of television receiving sets in the light of the recent rapid commercial developments in radio receiving sets.

A complete display of mechanical equipment of all kinds will be held in Los Angeles by the International Machinery & Equipment Exposition during the Tenth Olympiad, Aug. 2-7, 1932. All types of conveying equipment and every kind of equipment for shop and factory application is expected to be included in the exposition in permanent buildings which have been erected for the purpose.

Standard dimensions, tolerances and specifications for vulcanized fiber, sheets, tubes, rods and rolls are given in a revised pamphlet just issued by the National Electrical Manufacturers Association. Specifications give standard values for mechanical and dielectric strength, specific gravity, hardness and water absorption and the methods to be used in testing. This pamphlet supersedes the third edition issued in January, 1930. It contains several new rules on tolerances for diameters of vulcanized fiber tubing and rods, standard length of sheets, and minimum dielectric strength for thin-weight, fiber and fish paper.



FAGEOL 28-pass. city service bus with "Travel-Out" engine. The subframe carrying the engine may be electrically extended in 30 sec., and the engine removed in 3 min. by loosening 4 bolts

More than 10,000 different associations and firms are now listed by the Division of Simplified Practice of the National Bureau of Standards as acceptors to simplified practice recommendations, according to EDWIN W. ELY, chief of that division. There are now in effect over 120 simplified practice recommendations, and the total acceptances to all recommendations number nearly 30,000. Savings, due to the application of simplified practice recommendations, according to responsible sources, total more than $250,000,000.

New Federal Specifications include QQ-F-191 for ferrotitanium, succeeding USGMS 144, and QQ-C-501, superseding USGMS 467 on copper bars, plates, rods, shapes, sheets and strips.

The Porcelain Enamel Institute, 612 North Michigan Ave., Chicago, has added a Manufacturers' Technical Consultation Service to its other activities.

Foundry Standards Committee Appointed

The organization of the sectional committee on standardization of foundry equipment has just been completed under the procedure of the American Standard Association. E. S. CARMAN, president of Edwin S. Carman, Inc., Cleveland, is chairman of the committee, and JOHN J. BAUM, formerly development engineer of the Steel Founders Society of America, was appointed secretary. The work of the committee has been divided between three sub-committees, which will cover the following subjects:

Subcommittee 1—Pattern plates, molding machine parts, affecting interchangeability of patterns, flask pins and holes, general dimensions of stock flasks for jobbing work.

Subcommittee 2—Ladle and ladle shank sizes, ladle sleeves, stoppers and nozzles.

Subcommittee 3—Stock core print sizes, shapes and finish allowances, pattern markings, rapping plates, fillet sizes, dowel pins for metal patterns and metal core boxes.

The project is under the joint sponsorship of the American Foundrymen's Association of the A.S.M.E.

Design Functions Classified by Activity

Speaking before the Machine Design Division, at the annual meeting of the Society for the Promotion of Engineering Education held at Purdue University, June 19, 1931, EDWIN H. BROWN divided the functions of design engineers into three parts, namely, (1) apparatus design; (2) plant design and (3) design analysis.

Apparatus design is considered as covering the field of machine design and kinematics, heat transfer apparatus, and machines and apparatus that have to do with the flow of fluids, and requires men having the faculty for devising ingenious parts and motions. Plant design is considered as that branch which arranges machines or groups of machines that serve as a unit into a producing plant, individuals in this field being required to observe closely, summarize concisely, and be of an attractive personality that invites cooperation.

The term "design analysis" was applied by Mr. Brown to that phase of designing work which has become of great importance to the general administration of industries. Design analysis comprises the mathematical application of the laws of thermodynamics, hydraulics, stress determinations and vibration effects from inertia forces and rotating parts. It frequently has placed on it the burden of determining whether a proposed machine or a process of manufacture or operation that is in accord with scientific laws is practical as a commercial art. This work is also related to the functions of engineering economics, and has grown to be the tie between the work of the laboratory, the development floor or shop, and those engaged in apparatus and plant design. It requires a broad type of technical knowledge.

International Congress For Testing Materials

The first International Congress of the New International Association for the Testing of Materials will be held this year from Sept. 6 to 12 in Zurich, Switzerland, in the buildings of the Swiss Federal Polytechnicum. The Association consists of individuals and companies in the various countries. In the United States, the national association through which contacts are established is the American Society for Testing Materials, and many of its members belong to the international body. Objects of the Association are to secure international cooperation, exchange of views and experience in regard to all matters connected with the testing of materials. The chief means of securing this result is the holding of periodic International Congresses at intervals of from three to five years. The work does not involve standardization of materials, which is one of the chief functions of the A.S.T.M.

The technical program has been divided, into four groups as follows: Metals, non-metallic inorganic materials, organic materials and general.

New Patent Law Of the U.S.S.R.

A new statute on inventions and technical improvements, ratified by the government, came into force in the Soviet Union on May 25. This law differs from the previous patent law, dated 1924, in that not only does it provide for extending to the inventor exclusive rights to the invention (i.e., grant of patent), but it also provides merely for the recognition of his authorship (grant of certificate of authorship), depending upon the demands of the inventor. All matters concerning the issue of patents and certificates of authorship are under the control of the Committee on Inventions of the Council of Labor and Defense of the U.S.S.R.

Two fundamental conditions which may be of interest to foreign applicants are (1) foreigners have the same rights as citizens of the U.S.S.R., and (2) as was provided under the previous patent law, persons living abroad must authorize a permanent resident in the U.S.S.R. to represent them in conducting their patent affairs.

Patents are issued only for new inventions which may have a practical use in industry. They are also issued for new methods of preparing medical, food, and flavoring substances, and other substances obtained by chemical means, but not for the substances themselves.

News of the Metal Markets

COPPER has been again on a downward trend, being sold at 7.75c. on July 15, which is an all-time low price record, according to *Metal and Mineral Markets*. The German financial crisis is claimed to be the cause of the further depression in the metal markets. Both Germany and France imported more copper during the first four months of 1931 than during the same period last year, probably partly for reserve at the prevailing low prices.

LEAD markets are "dull but firm," with the metal selling at 4.40c. New York. The world production of lead declined sharply in May, reflecting the world-wide movement to curtail output. The Lead Producers' Association announces a further curtailment of 5 per cent beginning July 1.

ZINC trading has been more active, with the price at 3.90c. The renewal of the zinc cartel is being considered a favorable development.

TIN was being quoted below 25c. during the middle of July with only a fair business and little indication of stability in the market. Continued low prices of tin may have an effect in increasing the use of tin-base alloys for fine die castings. In view of all the substitute bearing metals developed during the period of high tin prices, it is doubtful if tin consumption for bearings will increase greatly.

ALUMINUM, "Alcoa" commercial ingot, 99-98 per cent, was quoted on July 16 at 23.30c. Remelted electrolytic nickel is quoted at 36c. Quotations on cobalt from Belgium were $2.50.

SCRAP metal prices have dropped naturally because of the depressed condition of the metals market. The copper scrap price dropped ½c. per lb. and brass ¼c. Ingot makers' prices are nominally 6c. on light copper and 3.50c. on mixed heavy brass. A large lot of aluminum offered by Rock Island Arsenal brought 2.915c. per lb. Remelt 98-99 per cent aluminum ingot is quoted at 18c. Brass composition ingot 85-5-5-5 is being sold in carload lots at 8⅛c.

Meetings

Society of Automotive Engineers—National Aeronautic meeting, Hotel Statler, Cleveland, Ohio, Sept. 1-3. John A. C. Warner, secretary, 29 West 39th St., New York, N. Y.

International Association for the Testing of Materials — First International Congress, Burich, Switzerland, Sept. 6-12. Information from C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

National Association of Power Engineers—Annual convention and mechanical exposition, Kansas City, Mo., Sept. 7-11. Fred W. Raven, secretary, 417 South Dearborn St., Chicago, Ill.

Steel Founders' Society of America, Inc.—First fall meeting, Chicago, Ill., Sept. 17. Granville P. Rogers, managing director, 932 Graybar Bldg., New York, N. Y.

National Metal Congress and Exposition—Exposition on Commonwealth Pier, congress sessions at Hotel Statler, Boston, Mass., week of Sept. 21. W. H. Eisenmann, secretary A.S.S.T., 7016 Euclid Ave., Cleveland, Ohio.

American Welding Society — Semi-annual meeting, Boston, Sept. 21-25. M. M. Kelly, secretary, 33 West 39th St., New York, N. Y.

American Society for Steel Treating—In connection with the National Metal Congress, Boston, Sept. 21-26. W. H. Eisenmann, secretary, 7016 Euclid Ave., Cleveland, Ohio.

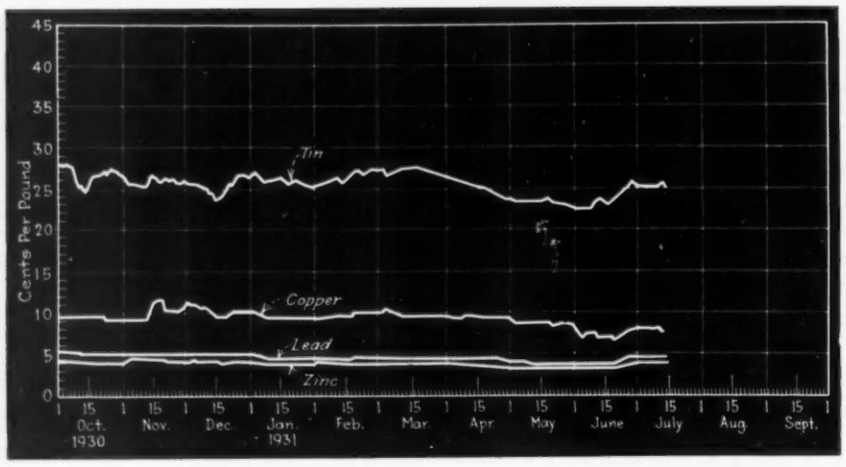
American Gas Association—Annual convention and exposition, Municipal Auditorium, Atlantic City, N. J., Oct. 12-16. Kurwin R. Boyes, secretary, 420 Lexington Ave., New York, N. Y.

National Safety Council—Twentieth annual Safety Congress (show in connection) Stevens Hotel, Chicago, Ill., Oct. 12-16. W. H. Cameron, secretary, 20 North Wacker Drive, Chicago, Ill.

Gray Iron Institute—Fourth annual convention, West Baden Springs Hotel, West Baden, Ind., Oct. 15-16. J. Arthur Tuscany, secretary, Terminal Tower, Cleveland, Ohio.

Steel Founders' Society of America, Inc.—New York meeting, Oct. 22. Granville P. Rogers, managing director, 932 Graybar Bldg., New York, N. Y.

Dairy & Ice Cream Machinery & Supplies Association—Annual meeting and exposition, Atlantic City, N. J., Oct. 26-31. C. E. Breece, secretary, 225 West 34th St., New York, N. Y.



C. F. Kettering says:

1. Business will come back when we get some products that people want to buy.

2. Monotony, or the sameness of products, is the thing that discourages buying.

3. Research is simply to find out what you are going to do when you cannot keep on doing what you are doing now.

4. We are just beginning to realize now that it takes a long while to develop a new line of products, and that you cannot do it overnight.

5. We are not going to get any great building up of business until we recognize that we must have products of a different order.

6. I have no objection to the standardization of bolts and nuts, but I have a terrible obsession against the standardization of ideas. . . . They say: "We have advertised this and now if we change, we have to change our advertising too!"

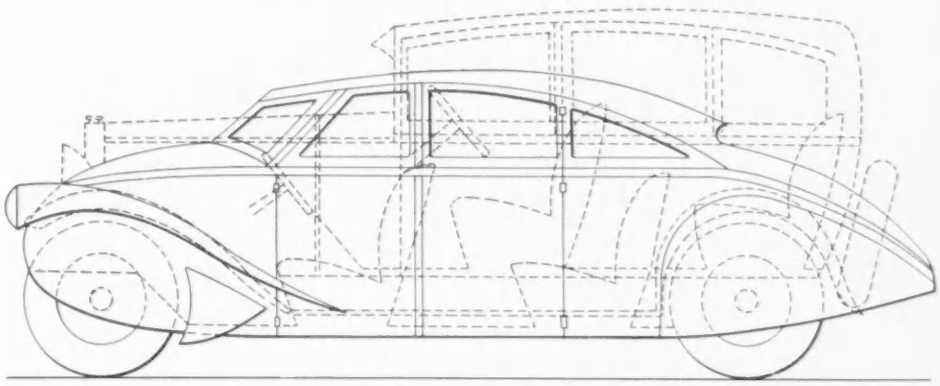
7. You do not have to change if you do not want to. We will let the sheriff take care of you.

8. If you want to kill any idea in the world, get a committee working on it. If you want to iron a thing down to the most simple, commonplace, low form of mediocrity, get a committee to pick the flaws in it!

9. We have a lot of systems, and we have a lot of other things, and . . . we have forgotten about this elementary thing, which is the product we have to sell.

10. A gentleman said, "I think we have industrial scurvy."—We are just lacking today a few of those fundamental vitamines of business. Put some of the spiritual things back into business, begin to put individuality into the product, so that you and I can express a life of non-standardization.

THE above is abstracted from a talk given by the vice-president of the General Motors Corporation before the Advertising Federation of America in New York on June 17.



STANDARD sedan and Fishleigh streamlined "tear-drop" car superimposed in outline for dimensional comparison

Radical Changes Coming in automotive design

By HERBERT CHASE

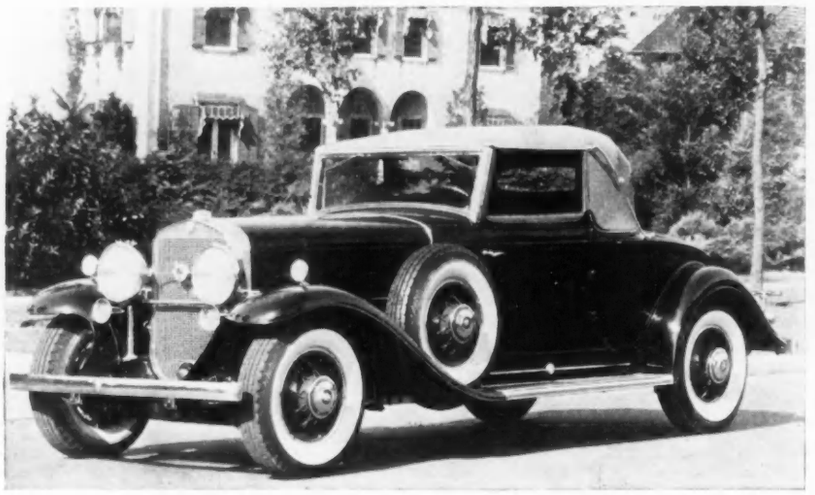
INDICATIONS that far-reaching changes in automobile design are brewing have come to light. Not only are most units in the chassis likely to be redesigned, but the whole arrangement of the chassis appears destined for a revision that will place the engine in the rear along with the power-transmitting elements. Bodies are certain to undergo a radical change also, partly to adapt them to the new chassis arrangement and partly to reduce their resistance to passage through the air by approximating a streamline form. Few sweeping revisions are anticipated at the automobile shows next January, but unless indications fail, they will be found in abundance at the show a year later.

In view of the excellent average performance of cars offered by American manufacturers today, it may well be doubted in some quarters whether radical changes are necessary or desirable. Certainly the manufacturers will not be disposed to make them as long as they can market readily a conventional product. This condition is not different from that faced by the products in many other fields. There is too great a similarity between different makes of cars; too much near copying of competitors' designs; too little opportunity for the engineer to use his imagination in making something well in advance of present practice. The designer needs a freer hand.

It is a significant fact that the only automobile manufacturer who has found it possible to work his plant at or near capacity this year is one who has gained a reputation for advanced designs.

There are abundant engineering reasons for the proposed improvements. Among these is the fact that present powerplants take nearly half the chassis space and necessitate a long and more expensive car, or require the body designer to cramp the space allowed for passenger and baggage, usually placing the rear seat directly over the rear axle, where it is difficult to make passengers comfortable.

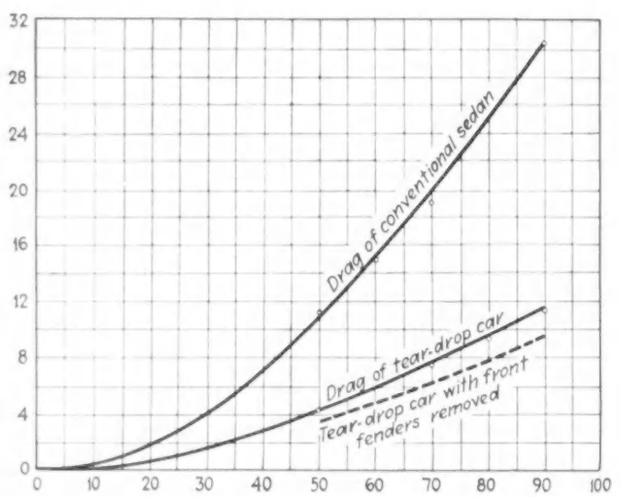
In the second place, all conventional cars present unnecessary drag or resistance to passage through the air, fully double as much as should be required by even a moderately streamlined body. Tests recently reported and based upon data secured in wind tunnel work with a conventional and a streamlined sedan, indicated that the total road resistance of the former (rolling plus wind) is 1.7 times as great as that of the latter at 40 miles an hour, and 2.3 times as great at 90 m.p.h. At lower speeds the difference is less, but still is great enough to make a considerable difference in the fuel and power required. It will thus be seen that a streamlined car can be propelled by a smaller engine than a car of current design, or can have a higher power-weight ratio.



CADILLAC V-12 convertible with Fleetwood body is representative of the fullest development of present front-engine type design

To make the most of streamlining, however, and also to give best seating arrangements in a car of given wheelbase, it is desirable to place the engine in the rear. Moreover, a number of other advantages are attainable by such a conversion, including less noise, heat, and odor in the passenger compartment, considerable savings in weight, decided improvement in riding comfort, and better forward vision for the driver. As pointed out in the December, 1930, number of *Product Engineering*, it is quite possible with rear-engine mounting to provide as much room for passengers in a car with Ford wheelbase as is now provided in a seven-passenger Lincoln sedan. Much can be done, however, to reduce the wind resistance of conventional cars without moving the engine from its present position. Such steps are a logical transition measure, and will do much toward making cars that are more quiet and easier to handle at high speed.

Another early improvement that can be anticipated is one that has been too long neglected, partly because primary interest has centered in engine development. Its purpose will be to make the car hold the road better than at present, to make the passengers more comfortable, and to prevent wheel wabble and transverse vibrations of the front of the vehicle which annoy the driver and give rise to other faults, especially at high speeds. Efforts to decrease unsprung weight and to improve springing, and certain shock-absorbing devices are among the items receiving much study. Many engineers see great promise in designs that do away with the ordinary form of axle and support the wheels separately on hinged links or springs. To date no American manufacturer with any considerable output has adopted such a design, but some are giving it consideration and a few European makers are employing it extensively. Its primary purpose is to minimize the transfer of road shocks to the chassis and body by permitting the wheels to be displaced separately without a corresponding displacement of the frame.



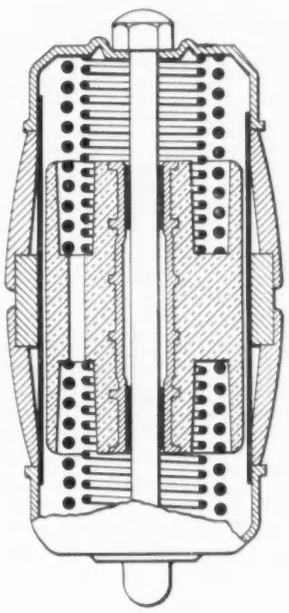
CURVES showing the comparative drag or wind resistance of a conventional sedan and the equivalent Fishleigh streamlined design

Transmissions and clutches also seem destined for marked alteration in which some form of free-wheeling device is likely to play an important part. Promising experiments are said to be under way with improved forms of friction drive designed to run in oil and employing hardened surfaces. A really simple means for doing away with the conventional gearset would be welcomed, but none of the substitutes thus far proposed seems to have gotten much beyond the experimental state.

Although free-wheeling has gained many advocates since its adoption by Studebaker, there are still engineers who are opposed to its use. A new form of device which provides free-wheeling as one of its advantages is likely to be announced at least as replacement equipment for Ford and Chevrolet cars. It consists of a vacuum cylinder and piston connected to the clutch and inlet manifold of the engine in such a way that, when the foot is taken from the accelerator, the clutch is thrown out automatically.

This vacuum clutch control operates in much the same way as brakes that are applied by a vacuum booster, but it requires no separate operating means. It can be thrown out of use, however, by shifting the hand throttle to a predetermined position. Brake operation by the use of a vacuum booster is now general in trucks and buses, and is employed also on the twelve- and sixteen-cylinder Cadillacs. Its further application to passenger car chassis of the larger sizes is expected.

Little seems to have been accomplished within the past year or two toward improvement in running gears and steering systems, except for the wider adoption of drop-center rims. One car manufacturer is expected to announce a sixteen-cylinder chassis in which the axles, frame, and many other parts are made from aluminum alloys. This car is reported to weigh about 1,000 lb. less than one sixteen-cylinder car now in production, and 2,000 lb. less than another sixteen-cylinder model. This presumably will mean a reduced operating cost and still make a high power-weight ratio possible, with a correspondingly improved accelerating ability.



HARMONIC stabilizer fitted to the front end of the latest Packard chassis and intended to counteract transverse shake

Although engine development is considered well in advance of that of the remainder of the chassis, and engines are capable of driving cars much faster than they can be driven safely on most roads, efforts toward higher specific power output and other engine improvements are not being neglected. At least one promising rotating-sleeve valve engine has been developed, and poppet valve manufacturers are making extensive studies with a view to improving valve cooling and valve life, for the exhaust valve is still one of the factors that limit the compression pressure and power output of the modern engine. One promising development in this regard is a valve having a high silicon-chromium steel body and a core of copper or aluminum to assist rapid conduction of heat from the head of the valve to its stem and thence to the water-cooled guide bushing. Some engines now have standard heads that give a six to one compression ratio, whereas a 4.5 to 1 ratio was considered high a few years ago.

Cooling has been giving trouble on some large size engines in particular, and is one factor likely to see revision. Most promising results have been attained with steam cooling, that is, with systems in which water is evaporated in the cylinder jacket, condensed in a radiator, and returned to the jacket. Such systems have involved certain difficulties, but all of these, including that of steam discharged as a result of residual heat in the engine when the latter is stopped after a hard run, now seem to have been overcome. One engineer with a prominent automobile company stated some two years ago that the last mentioned fault alone stood in the way of general adoption of steam cooling. Such cooling, although it involves higher mean temperatures, probably reduces the maximum temperatures which are the ones that cause trouble in water-cooled engines. It permits the use of a smaller and lighter radiator, and simplifies temperature control. In addition, it makes possible the steam heating of bodies by light, inexpensive radiators that require only small pipe connections and are superior to exhaust heaters.

Although automotive Diesel engines have been developed and give considerable promise for heavy-duty service, few engineers expect them to displace spark-ignition types in passenger cars for private use. There is some talk, however, of developing engines operating on the Otto cycle in which the fuel will be fed by an injection pump direct to the cylinders or to the manifold.

TYPES of poppet valves with Silchrome body and cores of sodium and copper designed to increase the conduction of heat from head to stem

✦ ✦ ✦

IN THE SPOTLIGHT—

AMBROSE SWASEY, founder of The Engineering Foundation, has added $250,000 to his previous gifts to the Foundation, bringing their total to the furtherance of research in science three-quarters of a million dollars, "for and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind."

STERLING F. ASHLEY, formerly assistant chief draftsman of the New York Central Railroad, has been appointed sales engineer of T. H. Symington & Son, Inc., Baltimore, Md. Mr. Ashley's experience has included the design and construction of new equipment and the maintenance of existing equipment. For the past five years he has also been engaged in research work pertaining to the operation of freight car trucks and truck springs, in connection with road tests and investigations conducted by the New York Central test department.

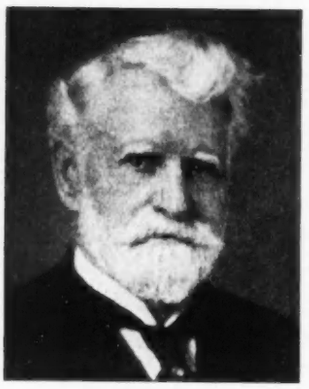
ROBERT W. AVER, formerly with the engineering department of the Granville Brothers Aircraft Corporation, Springfield, Mass., is now with the engineering department of the Stinson Aircraft Corporation, Detroit.

JOHN R. REPLOGLE has been appointed vice-president in charge of engineering of Copeland Products, Inc., of Mount Clemens, Mich. EDWARD HUGHES has been appointed vice-president in charge of manufacturing. Mr. Replogle is a pioneer in the electric-refrigeration industry and is credited with perfecting many of the parts used in electric-refrigeration machinery. In 1919 he was made chief engineer of Frigidaire; later he was chief engineer of the Nizer Corporation and subsequently was connected with the Kelvinator Corporation.

ARTHUR J. SCAIFE of the White Motor Car Company has been nominated for president of the Society of Automotive Engineers. Vice-presidential nominees are: WILLIAM B. STOUT, Stout Engineering Laboratories, representing aircraft engineering; CHARLES L. LAWRANCE, president of the Lawrance Engineering & Research Corporation, aircraft engine engineering; ALFRED J. POOLE, of the United American Bosch Corporation, Diesel engine engineering; B. B. BACHMAN, Auto Car Company, motor-truck and motor-coach engineering; D. G. Roos, chief engineer Studebaker Engineering Corporation, passenger car engineering; ADRIAN J. NOORKEN, Hupp Motor Car Corporation, passenger-car body engineering; A. S. MCARTHUR, general superintendent of the Toronto Transportation Commission, transportation and maintenance engineering; J. E. PADGETT of the Spicer Manufacturing Company, production engineering. The three new councilors will be: H. T. WOOLSON, chief engineer of the Chrysler Corporation; R. D. WILSON, director of the Standard Oil Co. of Indiana; and S. O. WHITE, chief engineer of the Warner Gear Company. The three which will hold over for another year are: F. S. DUESENBERG, NORMAN G. SHIDLE, and C. E. TILSTON. Other members are G. W. SPICER, EDWARD P. WARNER, VINCENT BENDIX and JOHN A. C. WARNER.

C. G. BACON, director of wheel research, Armco Railroad Sales Company, has resigned, but is being retained in a consulting capacity in connection with wrought iron wheels.

R. D. BEAN, formerly manager of the Engineering Development Department of the Brown Instrument Co., Philadelphia, has been made chief engineer.



Ambrose Swasey

John R. Replogle

Arthur J. Scaife

J. H. BIRDSONG, metallurgist of Pratt & Letchworth, Inc., Buffalo, has been elected chairman, Buffalo chapter, A.S.S.T.

JAMES T. BUGBEE, formerly experimental engineer with the Tillotson Manufacturing Company, Toledo, Ohio, has become mechanical engineer engaged in research for the Texas Company.

L. P. CROSET has resigned as chief engineer of the Diesel Department of Aveling & Porter, Ltd., Kent, England, to become Diesel engineer with the Central Wagon Works, Ltd., Shrewsbury, England.

R. M. DOULL, formerly on the engineering staff of the Dominion Engineering Works, Ltd., Lachine, Que., is now connected with the Construction Equipment Company, Montreal.

M. J. ECKMAN, development engineer with the Federal Machine & Welder Company, Warren, Ohio, sailed July 18 to supervise the installation of welding machinery in France, England, Germany and Italy.

WARREN F. FARRAGER, formerly in charge of development and research for the Universal Oil Products Company in the Research Laboratories, Riverside, Ill., has become research chemist, head of the division of light products, Vacuum Oil Company.

ALEXANDER L. FIELD, formerly research engineer, Simonds Saw & Steel Company, Fitchburg, Mass., becomes a director of development and research for Rustless Iron Corporation of America.

B. B. FOGLER, until recently a consulting engineer of Cambridge, Mass., has become associated as engineer with the Purity Fibre Products Corporation, recently organized in Philadelphia, Pa.

WILLIAM V. FOSTER, previously engaged in experimental work in the engineering shop department, University of Michigan, has become a junior engineer with the Duplex Printing Press Company, Battle Creek, Mich.

O. HOLM-HANSEN, formerly designer for the Sikorsky Aviation Corporation, Bridgeport, Conn., has resigned to work on his own patents.

EDWARD HECTOR, formerly an assistant engineer with the Houde Engineering Corporation, Buffalo, has become an engineer for the J. H. Williams Company, also of Buffalo.

GORDON T. WAITE, formerly chief engineer for the Alliance Aircraft Corporation, Alliance, Ohio, has joined the office of the Inspector of Naval Aircraft of the United States Navy in the capacity of aeronautic engineer.

CARLTON H. WOLF, previously aeronautic engineer with the National Aircraft Engineers, Inc., of the City of Washington, has been employed by the Kellett Aircraft Corporation.

CHARLES E. SKINNER, assistant director of engineering, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been elected president of the American Institute of Electrical Engineers. H. R. WOODROW was elected treasurer. The Lamme Medal, awarded annually by the Institute for meritorious achievement in the department of electrical apparatus or machinery, was presented to DR. WILLIAM JANES FOSTER, of Schenectady, N. Y., for "his contribution to the design of rotating alternating current machinery." Other officers elected include: Vice-Presidents, W. B. KOUWENHOVEN, Baltimore, Md.; W. E. FREEMAN, Lexington, Ky.; PAUL H. PATTON, Omaha, Neb.; A. W. COPLEY, San Francisco, Calif.; L. B. CHUBBUCK, Hamilton, Ont. Directors, L. W. CHUBB, East Pittsburgh, Pa.; B. D. HULL, Dallas, Tex.; H. R. WOODROW, Brooklyn, N. Y.—National Treasurer, W. I. SLICHTER, New York, N. Y.

JOHN R. FREEMAN, civil and mechanical engineer of Providence, R. I., and past president of the A.S.M.E., was awarded an honorary degree of Doctor of Science at the annual commencement of Yale University.

HARRY L. GIBSON, formerly a member of the experimental department National Parks Airways, Butte, Mont., has become a designing engineer in charge of aircraft and high speed internal-combustion engine design for the Miller Airplane Products Company, Los Angeles.

M. C. TERRY has been appointed refrigeration engineer at the East Springfield (Mass.) works, Westinghouse Electric & Manufacturing Company.

JAMES E. GLIDEWELL, formerly engineer of the Hall-Scott Motor Car Company, Berkeley, Calif., has been promoted to assistant chief engineer.

RALPH G. GRAHAM, formerly in charge of the gear laboratory for the Muncie (Ind.) Products Division, General Motors Corporation, has been made chief inspector in the airplane division of the South Bend (Ind.) plant of the Bendix Aviation Corporation.

NORMAN N. TILLEY has been placed in charge of engineering of the engineering division, American Airplane & Engine Corporation, New York, successor to the Fairchild Aviation Corporation. He was formerly chief engineer of the Kinner Airplane & Motors Corporation, Glendale, Calif. D. J. LOWMAN has been placed in charge of experimental engineering.

FRED GROTTS has joined the Continental Roll & Steel Foundry Company, East Chicago, Ind., as metallurgical engineer with headquarters there.

FRED J. GRIFFITHS, president of the Republic Research Corporation, Massillon, Ohio, since April, 1930, has been made a director of the Eaton Axle & Spring Co., Cleveland. He was formerly chairman of the Central Alloy Steel Corporation.

J. H. NEAD, formerly chief metallurgist of the American Rolling Mill Company, Middletown, Ohio, has taken a similar position with the Inland Steel Company.

CARL GUSTAFSON has become a designing draftsman with A. Bol Volvo, Gothenburg, Sweden.

EARL S. HUTTON has severed his connection after 4½ years as chief tool designer with the Hudson Motor Car Company. Since leaving Hudson, Mr. Hutton has organized the Hutton Engineering Products Co., 13150 Flanders Ave., Detroit, Mich. Mr. Hutton and his associates will specialize in the industrial field as designing engineers on special machine tool products. He has been connected with such firms as Packard, Lincoln, Cadillac, Duesenberg and Hudson over a period of 21 years.

Charles E. Skinner

M. C. Terry

Norman N. Tilley

HAROLD D. HOEKSTRA, formerly chief airplane engineer for the Crosby Aircraft Co., Sharonville, Ohio, has become aeronautic engineer with the Ford Motor Company, Dearborn, Mich.

W. C. MANDER, for many years associated with the Nordyke & Marmon Co., Indianapolis, as chief engineer, has been appointed sales and milling engineer for the flour mill machinery department, Allis-Chalmers Manufacturing Co., to succeed the late James Forrest.

LT.-COL. EARL MCFARLAND, Ordnance Department, United States Army, has been awarded the Distinguished Service Medal, the citation for which is as follows: "For exceptionally meritorious and distinguished service while in charge of the design, development and production of all machine guns, automatic rifles and accessories thereto during the World War."

CHARLES W. MCKINLEY has been appointed chief development engineer for the AC Spark Plug Co., Flint, Mich., succeeding Joseph Zubaty, who leaves for Europe after eight years with the company.

WALTER SHERMAN MOODY, who has been in the engineering department of the General Electric Co., Pittsfield, Mass., for the past 43 years, has resigned and will become a consulting engineer.

F. L. ORTLA has been made chief engineer of the New England Automatic Coal Burner Corporation, Boston.

GEORGE F. PIROOMOFF, formerly technical assistant to the president, Brockway Motor Truck Corporation, Cortland, N. Y., has been elected vice-president in charge of engineering.

R. C. ROLFING, formerly vice-president and general works manager of the Hart-Parr Company, Charles City, Iowa, has been made general works manager of the Grigsby-Grunow Company, Chicago, succeeding ALBERT WEILAND, resigned. Mr. Rolfing had been in charge of engineering purchasing and traffic for Hart-Parr.

JOHN L. F. ROSS has joined the engineering staff of the Ajax Manufacturing Company, Euclid, Ohio.

G. A. SCHREIBER, consulting engineer, whose European office is now affiliated with the firm of Koch & Kienzle, of Berlin, Germany, has returned to this country and will occupy his offices in Detroit until November of this year.

ALEXANDER SENOWSKI, formerly assistant manager and aviation engineer for the Polis Skoda Works, Warsaw, Poland, has accepted the post of technical director of the Institute of Aeronautical Researches, Warsaw.

G. D. SPACKMAN, president of Lukenweld, Inc., subsidiary of Lukens Steel Company, Coatesville, Pa., since its organization in July, 1930, has been appointed chairman of the American Welding Society's committee on the use of welded steel parts in the construction of machinery.

NEW MATERIALS AND PARTS AND ENGINEERING EQUIPMENT

Oilgear Type QR-2 and QWR-2 Variable-Delivery Pumps

Two styles of pumps with working pressures up to 1,500 lb. per sq.in. are being manufactured by the Oilgear Company, Milwaukee, Wis. Type QR-2 is a one-way, variable-delivery pump, having a capacity from 60 to 1,650 cu.in. per min. at a speed of 860 r.p.m. Type QWR-2 is similar but in addition has a constant and variable-pressure control from 500 to 1,500 lb. per sq.in. The former type is for use with cylinders and machines performing broaching, assembling, grinding, honing, planing, drilling, boring, and similar work, where it is essential to have a smooth straight-line motion. The latter is for use with machines performing assembling, squeezing, clamping and riveting work and in similar equipment where it is necessary to hold the work under a predetermined pressure for a period of time. Both of these units can be used in combination with an Oilgear constant-displacement fluid motor as variable-speed transmission.

Fig. 1—Oilgear Type QR-2 One-Way Variable-Delivery Pump in standard oil casing

Both pumps are of the multiple-plunger type, operating on the same principle as other Oilgear units. Oil is delivered in one direction only. A control valve must be used for reversing the flow of oil from the pump to a reciprocating cylinder or rotary motor. The amount of oil delivered is controlled by a lever located near the top of the pump, which varies the eccentricity of the multiple cylinder block with relation to the fixed piston carrier. In the Type QWR-2 pump full volume is delivered up to the pressure at which the control is set, when the stroke is reduced automatically to a point where the pump is delivering only sufficient oil to maintain that pressure. A relief valve is provided.

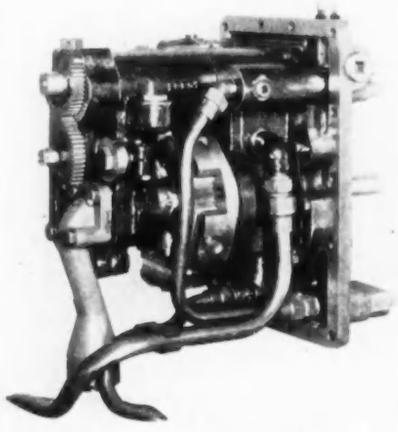


Fig. 2—Internal view of the Oilgear Type QR-2 Variable-Delivery Pump on its mounting flange. The swinging pendulum and control gear segments can be plainly seen

At full stroke and load these pumps have an efficiency of 90 per cent. Thrusts are carried on roller and ball bearings, and the working parts are easily accessible. An internal-gear pump supercharges and lubricates the high-pressure pump at all times. Both pumps are mounted on a flange and can be built into machines. When so installed, an oil reservoir must be provided. The pump can also be furnished with a standard oil casing having mounting feet or with a large combination oil reservoir and base arranged for direct motor drive. Under ordinary conditions a 3- to 5-hp. constant-speed motor is sufficient for drive, with a 7-hp. motor as the maximum.

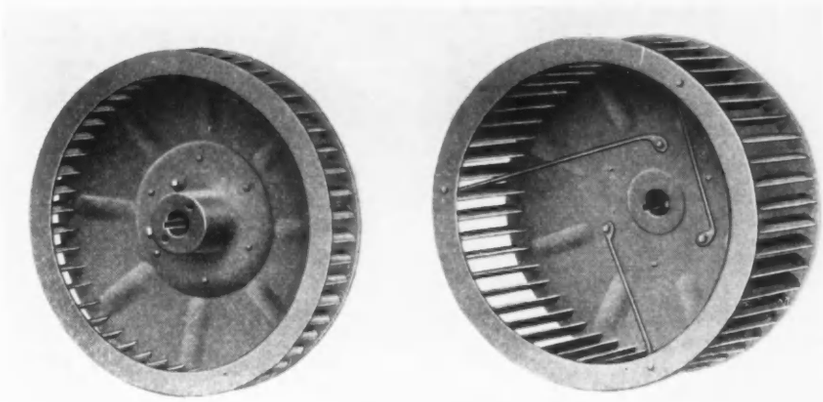
Pumps similar to the above, having a maximum working pressure of 2,500 lb. per sq.in., are also being built by the company.

"Sil-Fos" Silver Alloy for Brazing

A low-cost, low-melting-point silver alloy for brazing has been announced by Handy & Harman, 57 William St., New York, N. Y. This "Sil-Fos" alloy contains only a small percentage of silver and flows freely at 1,300 deg. F. It is applicable to work where higher-melting-point base-metal brazing or welding alloys cannot be used without danger of weakening, distorting or destroying the parts adjacent to the joint. Lap joints in copper sheets show a tensile strength of 30,000 lb. per sq.in., and the alloy can also be used for joining brass, bronze, nickel, nickel-silver, extruded brass and bronze, monel metal, and other metals and alloys fusing above 1,300 deg. F.

Clarage Type HV Fan Wheels and Assemblies

For use on unit stokers, oil and gas burners, and in forced warm-air furnace heaters, the Clarage Fan Company, Kalamazoo, Mich., is of-



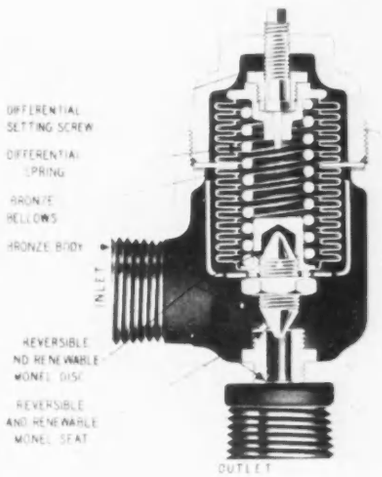
Left—Clarage Type HV Fan Wheel with internal housing
Right—Clarage Fan Wheel with tie-rod bracing

fering a line of Type HV fan wheels and assemblies. The fan wheels with the back-plate construction are offered in seven diameter sizes, and in each size the wheels can be furnished in varying widths from one-third to full width. Thus, regardless of air volume or pressure required, the proper wheel to operate at any desired motor speed can be furnished. The fan wheel consists of a large number of shallow steel blades securely anchored to the back plate and inlet rim. All blades are dieformed and the wheel back plate is rib stamped. The wheels can be furnished with either internal or external hubs of cast iron, the hubs being riveted to the back plate and heat-treated to meet requirements. Full width fans are furnished with tie rod braces connecting the back plate and inlet rim.

Standard equipment also includes two types of fan assemblies. The unit stoker assembly consists of a fan wheel, housing, inlet ring and inlet screen. The inlet ring can be furnished with a built-in damper in place of the inlet screen. The other assembly consists of a fan wheel, housing, inlet side plate, drive side plate, and support for mounting the motor. Both types of assemblies are offered with all seven sizes of fan wheels.

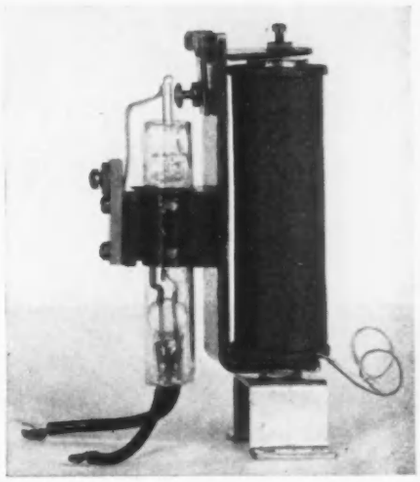
"Tag" Steam Trap

A steam trap for use with various types of process equipment has been developed by the C. J. Tagliabue Manufacturing Company, Park and Nostrand Aves., Brooklyn, N. Y. This trap has a differential setting feature, making it possible to discharge condensate at a temperature corresponding to a uniform differential pressure from 0 to 20 lb. below the operating steam pressure. When the differential setting screw is all the way up, there is no tension on the spring and the trap will discharge condensate from 1 to 2 deg. below the temperature of the operating steam. When tension on the spring is applied, by turning down the setting screw, a pressure is created on the inside of the bronze bellows which aids the vapor pressure developed in the bellows to close the valve. Thus, the amount of mechanical pressure exerted by the spring determines whether the trap will close at the temperature of the operating steam or 5, 15, or 25 deg. below that temperature. The Monel seats and disks are both reversible and renewable. The trap is made in a 1-in. pipe size only.



Burgess Vacuum Contact

A vacuum contact that can be operated by hand, by mechanical means, or by an electromagnetic agency, has been developed by the Burgess Battery Company, 295 Madison Ave., New York, N. Y. This device is for use wherever a positive, rapid and durable electrical contact is required in circuits handling up to 6 amp. on continuous load or 8 amp. intermittently, and up to 220 volts. It is adapted for use in telegraph and telephone systems, railway signaling and switching systems, fire alarm and burglar alarm systems, thermostats, traffic signals, controllers, advertising signs, rectifiers, electric ranges and other applications where a considerable wattage must be controlled by a minimum amount of energy.



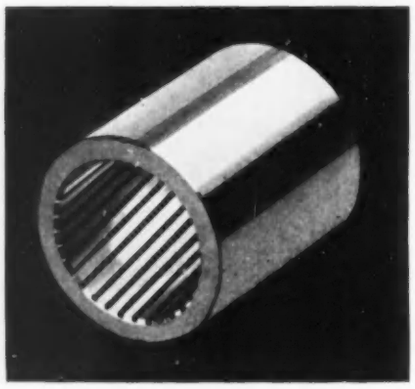
Burgess Vacuum Contact assembled to a telephone relay

The principle of the contact is that of the elasticity of a properly designed glass bellows which supports a glass rod actuating the contact in vacuum. The slightest pressure on the protruding glass rod serves to separate the contact members. A movement of only 0.02 in. at the end of the rod, which can be brought about by a force of less than 10 oz., and usually by a force of 6 oz., will cause the contact to function. Inasmuch as the contact is in vacuum, the contact members cannot oxidize.

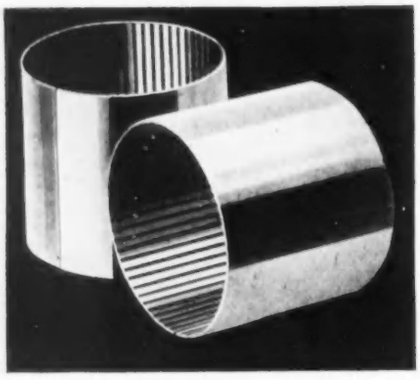
Johnson Self-Lubricating Bushings

Both cast and sheet-metal bushings have been placed on the market by the Johnson Bronze Company, New Castle, Pa. Nearly one-half of the interior is graphite impregnated. In the cast bushings, this result is accomplished by cutting dovetailed grooves approximately 1/32 in. wide into the bearing surface longitudinally on an angle of 7 deg. Any bronze alloy may be used for this self-lubri-

NEW MATERIALS AND PARTS



Johnson Cast Bushing with graphite slots in about one-half of surface



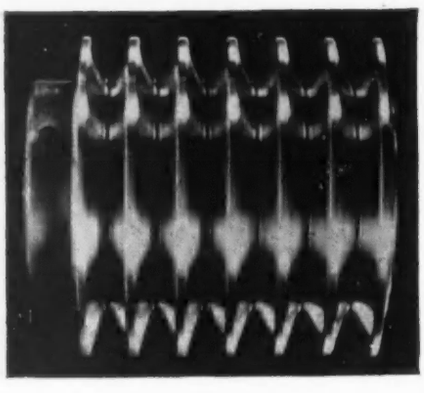
Johnson Rolled Sheet-Metal Bushings with dovetail slots for the graphite

cating bushing, without restriction as to size.

In the rolled sheet-metal bushing, grooves are cut into the strip metal, and, by forming the metal into cylindrical shape, the grooves automatically form a dovetail, which holds the lubricating compound in place.

American Wedgbelt Pulleys

Pressed-steel pulleys for V-belt drive have been developed by The American Pulley Company, 4200 Wissahickon Ave., Philadelphia, Pa.



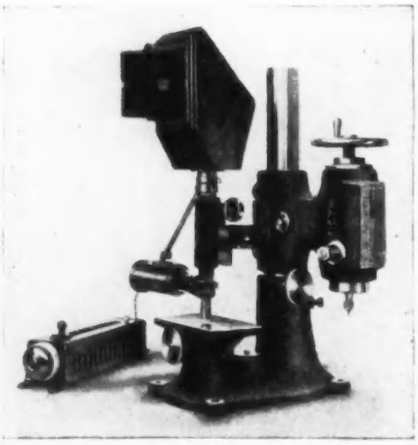
The grooves of these pulleys are made of bright steel stampings pressed for accuracy and having smooth surfaces. They afford correct angular relation to the belt and uniform belt stress regardless of the number of grooves. The metal sections insure rapid dissipation of frictional heat, and being non-abrasive reduce the belt wear. In addition, they are naturally balanced and are thus suitable for high-speed drives.

Complete Wedgbelt drives comprising V-belts and sheaves can be furnished.

Firth Hardometer Hardness Testing Machine

The Firth Hardometer hardness testing machine, manufactured by Thomas Firth & John Brown, Ltd., Sheffield, England, is being introduced into the United States by the Tinius Olsen Testing Machine Company, 500 North 12th St., Philadelphia, Pa. This machine operates on the standard Brinell principle, but uses lighter loads and either a small steel ball or a diamond pyramid as an indenter. The small steel ball is used on thin or soft materials and the diamond indenter on the hard materials such as carehardened, cyanided, or nitrided surfaces.

This machine has a micro-projection head which has the advantage of



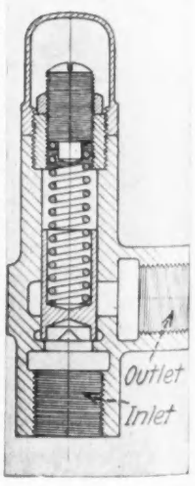
Firth Hardometer Hardness Testing Machine with a micro-projection head and a 30-kg. load cylinder

quicker readings so that it is especially adaptable for quantity production purposes. Loads of 120, 30 or 10 kg. are used, depending on the general character of hardness testing to be done. With the 120 kg. load, hard and medium steels down to 1 mm. thick or soft metals down to 2 mm. thick can be tested. This covers the average range of materials tested, and is the capacity generally used. With the 30 kg. load cylinder, similar materials down to $\frac{1}{2}$ mm. or 1 mm. thick may be tested. The 10 kg. load cylinder is used for very thin materials.

The Firth Hardometer differs from other instruments for hardness testing in that the diameter or diagonal of the impression is measured instead of the depth. The diameter or diagonal is from eight to sixteen times as great as the depth of impression, so that the instrument gives accurate and consistent results. In addition, a microscope is furnished to permit greater accuracy of reading. The indenter head and microscope are carried on two arms on a frame which can be quickly swung about a vertical center support post. With the micro-projection head the size of the indentation is shown on a ground glass directly before the eyes of the operator.

Fulflo Non-Chattering Oil-Relief Valve

A non-chattering, piston-type oil-relief valve, or bypass, is being marketed by the Fulflo Specialties Company, Blanchester, Ohio. This valve is made in pipe sizes from $\frac{3}{8}$ to $1\frac{1}{4}$ in., and is suitable for pressures from 20 to 120 lb. per sq.in. Adjustment can be made by removing the cap and turning the screw at the top. The cylindrical piston seat closes off the port in a shearing manner, and does not seat abruptly against the body of the valve, thereby preventing a pounding or chattering noise, and wear.



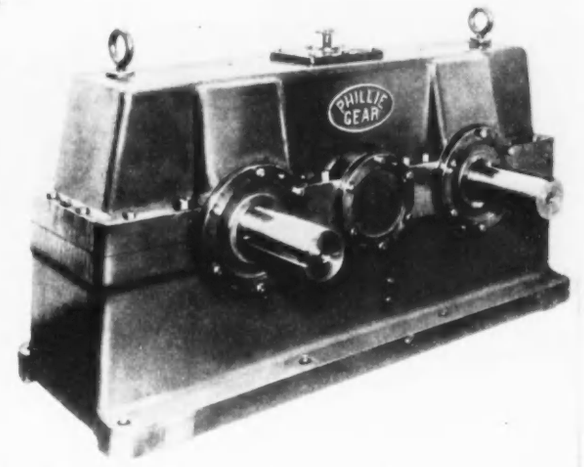
An important use of this valve is in connection with oil hydraulic pumping units where a specific pressure is desired to be maintained, such as on

NEW MATERIALS AND PARTS

machine-tool hydraulic mechanisms, presses, and oil-burning equipment. The valves are constructed of cast iron with a brass piston or of bronze.

Philadelphia Welded-Steel Speed Reducer Housings

The speed reducer units manufactured by the Philadelphia Gear Works, Erie Ave. and G St., Philadelphia, Pa., are now available with housings made of welded, rolled steel. These housings will resist impacts from heavy objects which would normally crush a cast-iron reducer housing. The speed reducers so housed are smooth-running, quiet in operation, and afford longer gear life from absence of vibration. Representative types are: horizontal worm-gear reducers; straight-line-drive, spur-gear reducers; straight-line drive, continuous-tooth herringbone reducers, right-angle drive, spiral bevel gear speed reducers, and others.



Philadelphia Herringbone-Gear Speed Reducer for straight-line drive, employing a welded steel housing for strength

Jones Herringbone-Maag Speed Reducers

A series of small herringbone-Maag speed reducers has been developed by the W. A. Jones Foundry & Machine Company, 4401 W. Roosevelt Road, Chicago, Ill. The capacities range up to 18 hp., and the reduction ratios from 12 to 1 up to 48 to 1. The

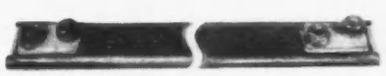
smallest reducer in this series is $20\frac{5}{16}$ in. long and $14\frac{1}{4}$ in. high, and the base measures $10\frac{1}{4}$ in. wide.

For universal application all the reducers in this series have high- and low-speed shaft extensions on both sides. This eliminates the need for a right- or left-hand assembly. Two shaft guards are provided.

On the high-speed side the herringbone gears and the high-speed pinion teeth are generated by rack-shaped cutters, with straight sides, used in a precision gear planer. On the low-speed side the Maag spur-tooth form is used for the gears because of the greater strength. This combination makes for an efficient, quiet reducer. Timken roller bearings are used throughout these units.

Trent Strip Heater

A modified form of strip heater is being manufactured by the Harold E. Trent Company, 618-640 N. 54th Street, Philadelphia, Pa. This strip heater contains two complete electrical circuits, wholly insulated from each other, each circuit extending the full length of the unit from the terminals at one end to the terminal block at the other end. Thus, with the convenience of a single strip, this strip heater enables application as a two- or three-phase heater or resistor, or a three-heat unit always heated over the full length for one, two, or three heats. It is also adapted for heating narrow surfaces and pipe lines where heat regulation is required. These units can be made in any length and for commercial voltages, and with or without perforated ends for mounting in position.



"L.-P." Ball and Socket Conveyor Chain

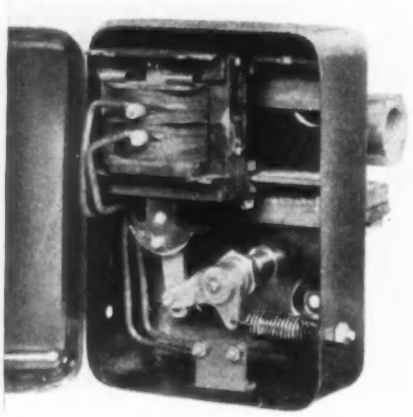
A ball and socket conveyor chain originally designed for the dairy industry, but adaptable to any type of conveying work, is announced by the Lathrop-Paulson Company, 2459 W. 48th St., Chicago. Each link is designed with a ball on the forward end and a socket in the rear end. With this construction, it is possible for the conveyor to make a 90-deg. turn in a 9-in. radius in the horizontal plane and to flex it in a perpendicular direction around a 6-in. idler sprocket.

The links are assembled by hand, and it is impossible for the chain to come apart unless the ball of one link is shoved forward to clear the socket bearing of the other link, which is then lifted upward off the ball. Owing to the semi-inclosure of the ball and socket joint, efficient lubrication is possible. The socket end of the link is notched on one side to allow for a short-turning radius around a return idler pulley.

General Electric Solenoid-Operated Valve

A solenoid-operated valve, designated as CR-9507-A1, for controlling liquids and gases under pressure, has been announced by the General Electric Company, Schenectady, N. Y. The valve body is made of two sec-

NEW MATERIALS AND PARTS



Interior of General Electric Type CR-9507-A1 Solenoid-Operated Valve

tions with the upper section fastened to the lower by bolts. Standard pipe threads are used for connections. The gland connected to the operating mechanism is of the rotary type to reduce friction. Both the seat and poppet are ground to fit and the materials employed in the construction are suited to the liquid or gas to be controlled. The valves can be made normally open or normally closed, in the field, by drilling mounting holes in the case and transferring the solenoid and operating mechanisms to the opposite side. The operating mechanism is so arranged that the solenoid plunger is permitted to accelerate without load for a fraction of the stroke, thereby obtaining quick operation.

The valve is designed for controlling the flow of brine through cooling pipes, for remotely or automatically controlling the supply of gas or oil to furnaces, and for controlling the flow of water in the cooling jackets of compressors.

PUBLICATIONS

FOR THE ENGINEER'S LIBRARY

ALUMINUM, ELECTROPLATING. The Aluminum Co. of America, Pittsburgh, Pa., has brought out a pamphlet entitled "Electroplating Aluminum," covering the procedure for various aluminum alloys and giving designers typical applications of this finish.

BEARINGS. The Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo., has issued bulletin S-349 on steel-backed babbitt-lined bearings, which are used in its line of electric motors.

BEARING BRONZES. The U. S. Department of Commerce, Bureau of Standards, has published Research Paper No. 205 entitled "Bearing Bronzes with Additions of Zinc, Phosphorus, Nickel, and Antimony." Tests made included wear resistance, resistance to impact, Brinell hardness, and resistance to repeated pounding at several temperatures.

BALL BEARINGS. The Aetna Ball Bearing Manufacturing Co., 4600 Schubert Ave., Chicago, Ill., has issued a 68-page book entitled "Ball and Roller Bearings—A Handbook for Designers and Engineers," illustrating the ball thrust and radial roller bearings manufactured. Other items are listed, and complete technical and design data are included.

BALL BEARINGS. SKF Industries, Inc., 40 E. 34th St., New York, N. Y., has published bulletin No. 203 on preloaded ball bearings for precision spindles. Spindle mountings for several classes of machine tools are included.

CLUTCHES The Carlyle Johnson Machine Co., Manchester, Conn., is now distributing its Super-Johnson catalog, featuring the improvements and advantages of its new Super-Johnson clutch. In this new tpye of clutch, the expanding friction ring is faced on its outside diameter with a special heat-resisting material.

CLUTCHES, MAGNETIC. Cutler-Hammer, Inc., 12th & St. Paul Aves., Milwaukee, Wis., has issued a booklet "Keeping Pace with Machine Design," which deals with the construction, operation and application of "C-H" magnetic clutches and includes a full description of the new Duplex clutch.

CONTROL UNITS. The Allen-Bradley Co., 1311 So. First St., Milwaukee, Wis., has issued a complete set of new and revised bulletins and price sheets covering recent developments and improvements in a number of control units.

DISK CLUTCHES—The Twin Disc Clutch Co., Racine, Wis., has prepared an illustrated pamphlet showing pictorially the application of Twin Disc clutches and power take-off units for material handling, oil field and agricultural machinery. A new set of engineering data sheets, covering the entire line of clutches, has also been issued.

ELECTRIC ARC-WELDING DATA. The Hobart Brothers Co., Troy, Ohio, has published a book entitled "Electric Arc Welding," presenting such facts about the arc-welding process as are essential to successful applications. The manual is a brief and non-technical arrangement, and is profusely illustrated with examples of the application of the process in many industries. The price is $1.00.

ELECTRICAL RESISTANCE OF NUT AND BOLT CONTACTS. The U. S. Department of Commerce, Bureau of Standards, has issued Research Paper No. 227 entitled "Note on the Electrical Resistance of Contacts Between Bolts and Nuts."

FILTER UNIT, POWER. The Square D Co., 6060 Rivard St., Detroit, Mich., has issued a bulletin on the power filter unit described in these pages, the unit being used for converting alternating current into pure, non-pulsating, humless, direct current.

FUSIBLE ALLOYS. The U. S. Department of Commerce, Bureau of Standards, has issued Research Paper 248 entitled "Properties of Lead-Bismuth, Lead-Tin, Type Metal and Fusible Alloys," for sale by the Superintendent of Documents, Washington, D. C., for $0.10.

MOTORS. The Ideal Electric & Manufacturing Co., Mansfield, Ohio, has issued bulletin No. 520 on synchronous motors.

MOTORS. The Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio, has published bulletin No. 209 on the Type T, heavy-duty motors for d.c. applications.

RARE METALS. Fansteel Products Co., Inc., North Chicago, Ill., has issued a revised edition of the booklet "Rare Metals." Several items have been added since the booklet was first published in 1929, including a section on tantalum-carbide cutting tools, improved methods of refining and fabricating tantalum, tungsten and molybdenem, together with new uses for these metals. There are also new chapters on columbium, caesium and rubidium, which are finding increasing importance in industry.

SPEED REDUCERS. The Horsburgh & Scott Co., 5114 Hamilton Ave., N. E., Cleveland, Ohio, has issued a speed reducer catalog, containing 128 pages, and a selection chart of a number of types of speed reducers.

SPEED REDUCERS. The W. A. Jones Foundry & Machine Co., 4401 West Roosevelt Road, Chicago, Ill., has issued a catalog on worm gear speed reducers, containing in particular a chapter on "Selecting the Correct Worm Gear Speed Reducers for the Job."

THERMOMETAL. The H. A. Wilson Co., 97 Chestnut St., Newark, N. J., has published a catalog on "Wilco Thermometal," giving information on the type of bimetallic elements available and complete formulas and charts for calculating the deflections for various ranges of temperature.

Standard Tables for Design of Roller Chain Drives

Table I—Speed Ratio

This table gives the ratio of the revolutions per minute of the driven wheel to the revolutions per minute of the driving wheel for various tooth combinations.

Number of Teeth in Driven Wheel	Number of Teeth in Driving Wheel																		
	17	19	21	23	25	27	30	33	36	40	45	50	55	60	68	75	84	90	102
19	1.12	1.00	0.91	0.83	0.76	0.70	0.64	0.58	0.53	0.48	0.42	0.38	0.35	0.32	0.28	0.25	0.23	0.21	0.19
21	1.23	1.10	1.00	0.91	0.84	0.78	0.70	0.64	0.58	0.53	0.47	0.42	0.38	0.35	0.31	0.28	0.25	0.23	0.21
23	1.35	1.21	1.10	1.00	0.92	0.85	0.78	0.70	0.64	0.58	0.51	0.46	0.42	0.38	0.34	0.31	0.27	0.26	0.23
25	1.47	1.32	1.19	1.09	1.00	0.93	0.83	0.76	0.70	0.63	0.56	0.50	0.46	0.42	0.37	0.33	0.30	0.28	0.25
27	1.59	1.42	1.28	1.17	1.08	1.00	0.90	0.82	0.75	0.68	0.60	0.54	0.49	0.45	0.40	0.36	0.32	0.30	0.26
30	1.77	1.58	1.43	1.30	1.20	1.11	1.00	0.91	0.83	0.75	0.67	0.60	0.55	0.50	0.44	0.40	0.36	0.33	0.29
33	1.94	1.74	1.57	1.43	1.32	1.22	1.10	1.00	0.92	0.83	0.73	0.66	0.60	0.55	0.49	0.44	0.39	0.37	0.32
36	2.12	1.89	1.71	1.56	1.44	1.33	1.20	1.09	1.00	0.90	0.80	0.72	0.65	0.60	0.53	0.48	0.43	0.40	0.35
40	2.35	2.10	1.90	1.74	1.60	1.48	1.33	1.21	1.11	1.10	0.89	0.80	0.73	0.67	0.59	0.53	0.48	0.45	0.39
45	2.65	2.37	2.14	1.96	1.80	1.67	1.50	1.36	1.25	1.13	1.00	0.90	0.82	0.75	0.66	0.60	0.54	0.50	0.44
50	2.94	2.63	2.38	2.18	2.00	1.85	1.67	1.52	1.30	1.25	1.11	1.00	0.91	0.83	0.74	0.67	0.60	0.56	0.49
55	3.24	2.89	2.62	2.39	2.20	2.04	1.83	1.67	1.53	1.38	1.22	1.10	1.00	0.92	0.81	0.73	0.66	0.61	0.54
60	3.53	3.16	2.86	2.61	2.40	2.22	2.00	1.82	1.67	1.50	1.33	1.20	1.09	1.00	0.88	0.80	0.71	0.67	0.59
68	4.00	3.58	3.24	2.96	2.72	2.52	2.27	2.06	1.89	1.70	1.51	1.36	1.24	1.13	1.00	0.91	0.81	0.76	0.67
75	4.41	3.95	3.57	3.26	3.00	2.78	2.50	2.27	2.08	1.87	1.67	1.50	1.36	1.25	1.10	1.00	0.89	0.83	0.74
84	4.94	4.42	4.00	3.65	3.36	3.11	2.80	2.54	2.33	2.10	1.87	1.68	1.53	1.40	1.24	1.12	1.00	0.93	0.82
90	5.30	4.74	4.28	3.91	3.60	3.33	3.00	2.72	2.50	2.25	2.00	1.80	1.64	1.50	1.32	1.20	1.07	1.00	0.88
102	6.00	5.37	4.86	4.43	4.08	3.78	3.40	3.09	2.80	2.55	2.27	2.04	1.85	1.70	1.50	1.36	1.21	1.13	1.00
111	6.53	5.84	5.28	4.83	4.44	4.11	3.70	3.36	3.08	2.77	2.47	2.22	2.02	1.85	1.63	1.48	1.32	1.23	1.09
120	7.07	6.32	5.72	5.22	4.80	4.45	4.00	3.64	3.34	3.00	2.67	2.40	2.18	2.00	1.77	1.60	1.43	1.34	1.18
129	7.59	6.79	6.14	5.61	5.16	4.78	4.30	3.91	3.58	3.22	2.87	2.58	2.34	2.15	1.90	1.72	1.53	1.43	1.26

Table II—Working Loads and Horsepowers for Standard Roller Chains

Chain No.	Pitch, In.	Maximum R.P.M.	The Upper Figures are Rated Horsepowers—The Lower Figures are Loads in Pounds — Chain Velocity in Feet per Minute									
			50	100	200	300	400	600	800	1,000	1,300	1,600
35N	⅜	3,620	0.25 162	0.45 150	0.79 132	1.06 117	1.27 105	1.60 88	1.82 75	1.94 64	2.07 52	2.10 43
40	½	2,717	0.41 269	0.76 250	1.33 219	1.78 194	2.12 175	2.65 146	2.98 123	3.25 107	3.41 87	3.44 71
50	⅝	1,927	0.64 428	1.20 397	2.11 348	2.82 308	3.38 278	4.22 232	4.75 196	5.13 169	5.4 137	5.47 113
60	¾	1,454	0.93 645	1.80 597	3.03 524	4.06 462	4.86 419	6.07 348	7.15 295	7.68 253	8.10 206	8.20 169
80	1	941	1.66 1,092	3.07 1,014	5.58 891	7.20 785	8.64 712	10.8 592	12.1 507	13.0 431	13.75 349	13.85 286
100	1¼	652	2.41 1,592	4.48 1,478	7.88 1,294	10.5 1,153	12.6 1,035	15.7 862	17.6 727	18.85 622	19.9 506	20.0 412
120	1½	515	3.63 2,415	6.76 2,230	11.8 1,960	15.8 1,730	18.9 1,565	23.6 1,306	26.5 1,098	28.7 946	30.2 766	30.2 623
140	1¾	375	4.36 2,880	8.11 2,674	14.2 2,330	19.0 2,070	22.8 1,870	28.4 1,560	31.7 1,308	34.0 1,127	36.0 914	36.0 742
160	2	316	5.96 3,940	11.10 3,658	19.4 3,202	25.8 2,840	31.1 2,560	38.8 2,130	43.4 1,792	46.7 1,540	49.0 1,244	49.0 1,013
200	2½	224	10.06 6,636	18.70 6,161	32.7 5,390	43.6 4,790	52.3 4,320	65.4 3,600	73.5 3,030	79.0 2,605	84.0 2,130	84.0 1,742

These tables are based on sprockets having not less than 15 teeth.

Contributed by G. M. Bartlett, Professor of Machine Design, Purdue University, Consulting Engineer, Diamond Chain and Manufacturing Company

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Standard Tables for Design of Roller Chain Drives

Table III—Data for Standard Roller Chains

Mfgr. Std. No.	Pitch, In.	Width, In.	Roller Diam., In.	Approx. Weight per Ft. Lb.	Average Tensile Strength Lb.	Projected Pin Area, Sq.In.	Max. R.p.m.
35N	3/8	3/16	0.200	0.20	1,350	0.040	3,620
41	1/2	1/4	0.306	0.26	1,900	0.049	2,900
40	1/2	5/16	0.312	0.39	2,900	0.067	2,717
50	5/8	3/8	0.400	0.61	4,800	0.107	1,927
60	3/4	1/2	0.469	0.97	6,900	0.154	1,454
80	1	5/8	0.625	1.63	11,200	0.273	941
100	1 1/4	3/4	0.750	2.50	18,100	0.398	652
120	1 1/2	1	0.875	3.60	23,600	0.598	515
140	1 3/4	1	1.000	4.90	33,500	0.720	375
160	2	1 1/4	1.125	6.49	42,500	0.985	316
200	2 1/2	1 1/2	1.562	10.50	95,000	1.658	224

Table IV—Standard Pitch-Diameters and Outside Diameters of Sprockets for 1-In. Pitch Chains

No. of Teeth	Pitch Diameter	Outside Diameter	No. of Teeth	Pitch Diameter	Outside Diameter	No. of Teeth	Pitch Diameter	Outside Diameter
6	2.000	2.332	46	14.654	15.219	86	27.381	27.962
7	2.305	2.677	47	14.972	15.538	87	27.699	28.281
8	2.613	3.014	48	15.290	15.857	88	28.017	28.599
9	2.924	3.347	49	15.608	16.176	89	28.335	28.918
10	3.236	3.678	50	15.926	16.495	90	28.654	29.236
11	3.550	4.006	51	16.244	16.813	91	28.972	29.554
12	3.864	4.332	52	16.562	17.132	92	29.290	29.873
13	4.179	4.657	53	16.880	17.451	93	29.608	30.191
14	4.494	4.982	54	17.198	17.769	94	29.926	30.510
15	4.810	5.305	55	17.517	18.088	95	30.245	30.828
16	5.126	5.627	56	17.835	18.406	96	30.563	31.146
17	5.442	5.950	57	18.153	18.725	97	30.881	31.465
18	5.759	6.271	58	18.471	19.044	98	31.199	31.783
19	6.076	6.593	59	18.789	19.363	99	31.518	32.102
20	6.393	6.914	60	19.107	19.681	100	31.836	32.420
21	6.710	7.235	61	19.426	20.000	101	32.154	32.739
22	7.027	7.555	62	19.744	20.318	102	32.473	33.057
23	7.344	7.875	63	20.062	20.637	103	32.791	33.376
24	7.661	8.196	64	20.380	20.955	104	33.109	33.694
25	7.979	8.516	65	20.698	21.274	105	33.427	34.012
26	8.296	8.836	66	21.016	21.593	106	33.746	34.331
27	8.614	9.156	67	21.335	21.911	107	34.064	34.649
28	8.932	9.475	68	21.653	22.230	108	34.382	34.968
29	9.249	9.795	69	21.971	22.548	109	34.701	35.286
30	9.567	10.114	70	22.289	22.867	110	35.019	35.605
31	9.885	10.434	71	22.607	23.185	111	35.337	35.923
32	10.202	10.753	72	22.926	23.504	112	35.655	36.241
33	10.520	11.072	73	23.244	23.822	113	35.974	36.560
34	10.838	11.392	74	23.562	24.141	114	36.292	36.878
35	11.156	11.711	75	23.880	24.459	115	36.610	37.197
36	11.474	12.030	76	24.198	24.778	116	36.929	37.515
37	11.792	12.349	77	24.517	25.096	117	37.247	37.833
38	12.110	12.668	78	24.835	25.415	118	37.565	38.152
39	12.428	12.987	79	25.153	25.733	119	37.883	38.470
40	12.746	13.306	80	25.471	26.052	120	38.201	38.788
41	13.064	13.625	81	25.790	26.370	121	38.519	39.106
42	13.382	13.944	82	26.108	26.689	122	38.837	39.425
43	13.700	14.263	83	26.426	27.007	123	39.156	39.743
44	14.018	14.582	84	26.744	27.326	124	39.475	40.062
45	14.336	14.901	85	27.063	27.644	125	39.794	40.381

For other pitches multiply these values by the pitch.

To obtain bottom diameters subtract diameter of chain roller from pitch diameter.

Contributed by G. M. Bartlett, Professor of Machine Design, Purdue University, Consulting Engineer, Diamond Chain and Manufacturing Company

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